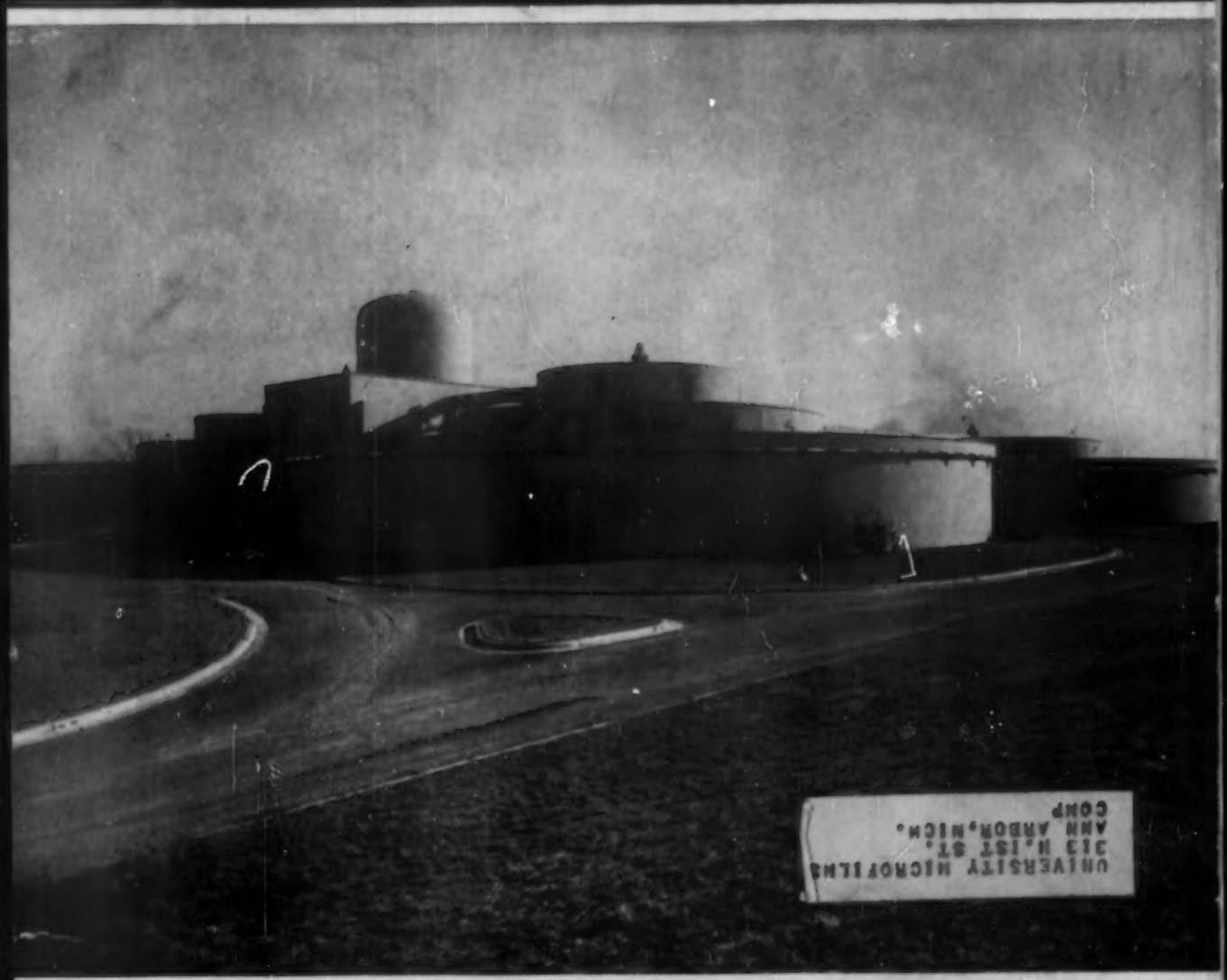
WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

A Scranton Gillette Publication



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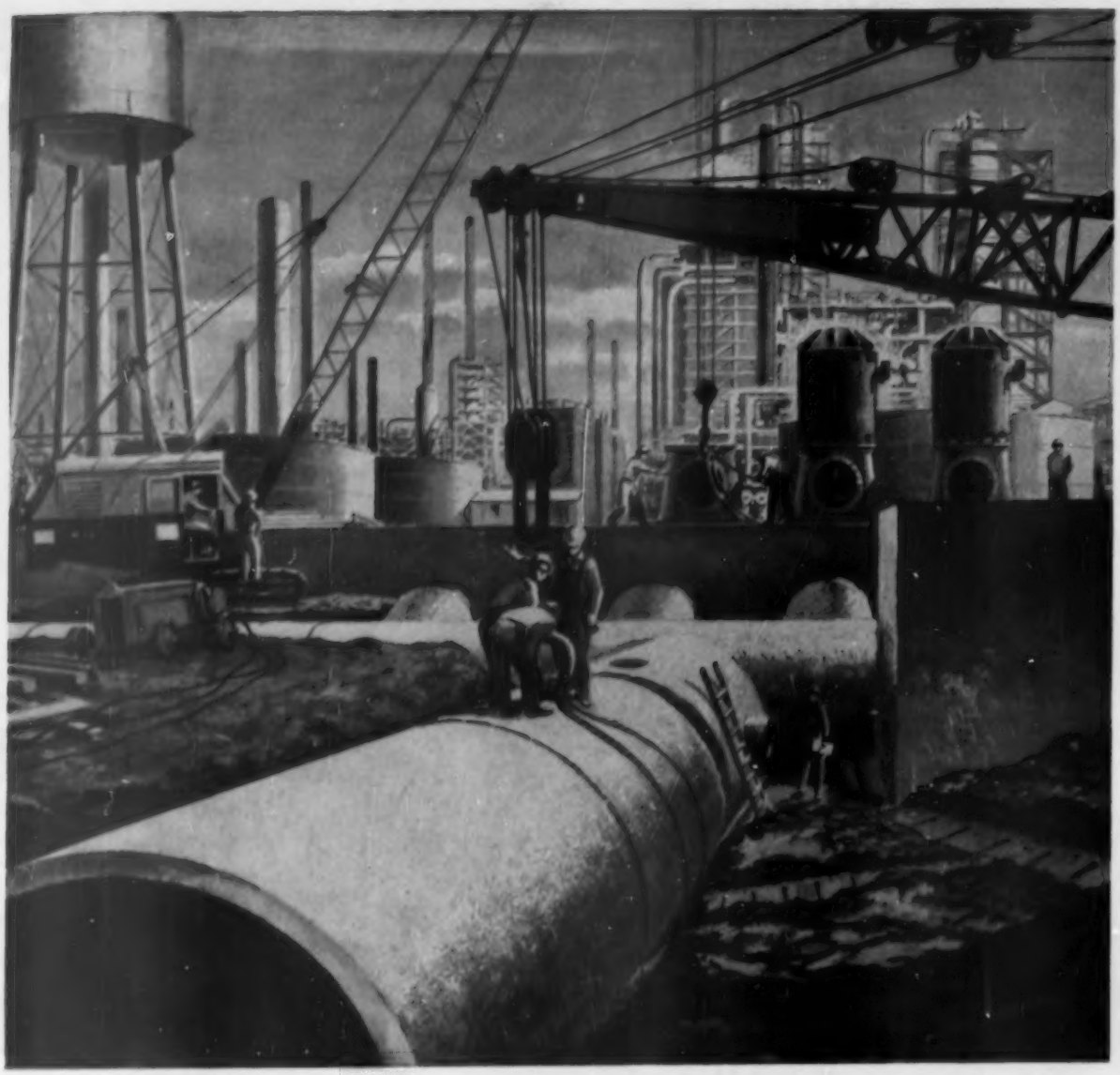
JANUARY 1957

Another Morse Filter Plant for Washington Suburban Distr.
Design of the late Robert Morse; built by the Chicago Br. & Iron Co.
(Pages 1-13)

Incentive Pay Plan Boosts Philadelphia's Meter Shop Output
(Pages 14-16)

Experiences With The "Biosorption" Process at Austin, Texas



Where OIL and WATER do mix!

It takes a staggering amount of water to run an oil refinery such as the one recently built for the Tidewater Oil Co. at Delaware City, Delaware. Specifications required twin 78" LOCK JOINT REINFORCED CONCRETE CYLINDER PIPE-LINES to supply water to this plant. The combined capacities of these two lines would satisfy the normal requirements of a city of over two million population.

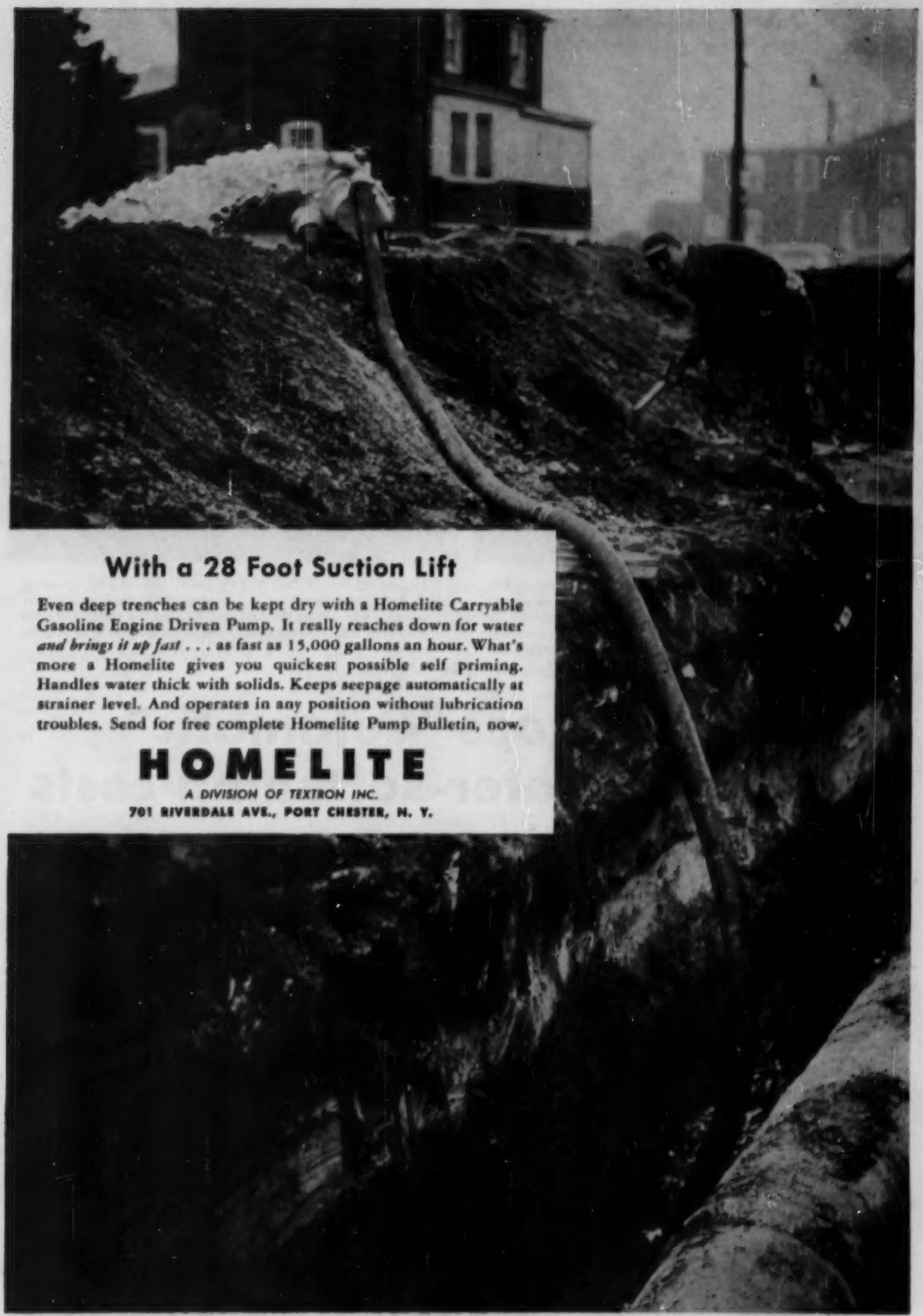
Only the most rugged and dependable type of pipe could be trusted to handle such volumes of water within the limited confines of a multi-million dollar plant. Yet Tidewater authorities are confident of the durability and safety of the refinery's Lock Joint supply lines because these characteristics are built into every Lock Joint pressure pipe through conservative design, careful choice of materials and expert workmanship.

LOCK JOINT PIPE CO.

East Orange, New Jersey

Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Mo.

Pressure • Water • Sewer • REINFORCED CONCRETE PIPE • Culvert • Subaqueous



With a 28 Foot Suction Lift

Even deep trenches can be kept dry with a Homelite Carryable Gasoline Engine Driven Pump. It really reaches down for water *and brings it up fast . . .* as fast as 15,000 gallons an hour. What's more a Homelite gives you quickest possible self priming. Handles water thick with solids. Keeps seepage automatically at strainer level. And operates in any position without lubrication troubles. Send for free complete Homelite Pump Bulletin, now.

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A DIVISION OF TEXTRON INC.

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AUTOMATIC HARDNESS TESTER on each softener makes soap tests at required intervals. When the water tests hard—regardless of the volume treated—the tester automatically activates the multiport valve that regenerates the softener . . . insuring maximum runs and uniformly soft water despite variations in wells.

AUTOMATIC MULTIPORT VALVE, being checked by operator Bob Fox, takes a softener out of service, backwashes, regenerates and rinses the bed and returns the unit to service—smoothly and automatically—with no attention or supervision.

East Aurora goes "automatic" and cuts water-softening costs

WHEN POPULATION JUMPED TO 6,800, East Aurora increased pumpage by 72% from 320,000 to 550,000 gpd. Even at this increased volume, they cut salt costs $4000 a year! They also ended a red-water problem by reducing iron from 1.3 ppm to 0. And they use the *same manpower!*

HOW WAS IT DONE? The increased volume and salt savings were accomplished by using Permutit Q, a high-capacity ion exchange resin with low salt consumption. The iron problem was solved with two Permutit filters. Manpower was not increased because the automatic hardness testers eliminated manual testing. And the efficiency of Permutit's automatic multiport valves frees the operators for other plant duties.

WHY PERMUTIT? "We started with Permutit equipment in 1935, and it worked out so well that we called on Permutit again for our 1950 expansion," says Village Engineer E. J. Maurer.

PERMUTIT WILL WORK WITH YOU to modernize your present plant or to plan a new one. Call us early in the planning so we can be of most help. The Permutit Company, Dept. W-1, 330 West 42nd Street, New York 36, N. Y.

A 51% increase in population caused East Aurora, N. Y. to expand and modernize its water works. Wooden structure (above) was replaced by a modern brick building which contains the latest in water conditioning equipment.

PERMUTIT® WATER CONDITIONING

Equipment • Resins • Experience

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

Vol. 104 No. 1

JANUARY 1957

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...for treating domestic and industrial wastes

18-month test shows HI-CONE system operating costs are 44% less!

than air diffusion system

- TESTS PROVE LOWER POWER COSTS!
- LOWER MAINTENANCE COSTS!
- BETTER EFFLUENT

In the selection of sewage treatment equipment, the two most important factors are operating cost and effluent quality.

These figures from the annual report of the Manchester, England, Rivers Department, *prove* the superiority of the Hi-Cone! They're based on the operation of activated sludge plants (including a Hi-Cone System and a diffused air system) under strictly comparable conditions over a period of 18 months. Manchester is a pioneer in treatment by the activated sludge process, having first conducted experiments and tests in 1913.

Hi-Cone's power consumption was lower! Horsepower demand per million gallons treated per 24-hour day for the Hi-Cone System was 34.9% lower than the air diffusion system.

Hi-Cone's total operating costs were lower! Relative costs per million gallons treated were 42.1% lower than the air diffusion system.

Hi-Cone's effluent was better! The B.O.D. reduction was 26% greater; the suspended solids removal was 5% greater than the air diffusion system.

Use this coupon to ask for detailed information

Please send the following descriptive literature on the Hi-Cone:

☐ Cost and operating reports ☐ Report of article, "U. S. and British engineers agree on the Hi-Cone System"

☐ Hi-Cone engineering data

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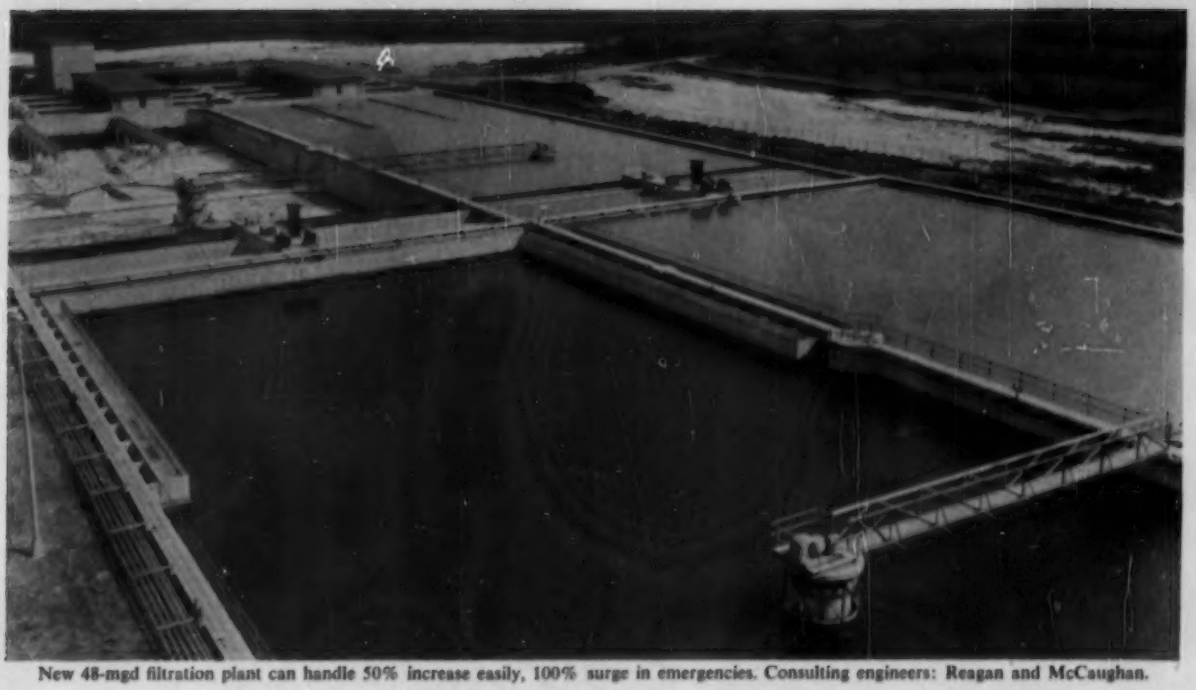

New 48-mgd filtration plant can handle 50% increase easily, 100% surge in emergencies. Consulting engineers: Reagan and McCaughan.

CORPUS CHRISTI, TEXAS

Produces pure, clear water from muddy Nueces River

with LINK-BELT collectors . . . mixers . . . chemical handling system

TYPE SC CIRCULINE SLUDGE COLLECTORS, with pivoted rakes at ends of arms, adjust to collect sludge in corners of basin.

STRAIGHTLINE SLOW MIXERS are used in primary and secondary chambers. Detention time: 45 minutes at 48 mgd capacity.

LINK-BELT SCREW CONVEYORS AND BUCKET ELEVATORS distribute lime, sulphate and alum to tanks for live or reserve storage.

WATER from the Nueces River supplying Corpus Christi is hard and muddy. To provide ample water for the rapidly expanding population—which has doubled each decade since 1920—treatment facilities featuring Link-Belt equipment were installed at the new O. N. Stevens water filtration plant. A two-stage treatment provides rapid and thorough solids removal . . . effectively reduces the river's 142 ppm hardness.

Link-Belt is supplying specific answers to specialized water, sewage and waste treatment problems for municipalities and industries throughout the country. A broad line of screens, collectors, mixers, conveyors and power transmission equipment offers durability that minimizes maintenance . . . helps you plan your requirements for the years ahead.

Let our engineers work with you, your chemists and consultants to assure top efficiency at all flow conditions. Call your nearest Link-Belt office for consultation with a sanitary engineering specialist.

14,124

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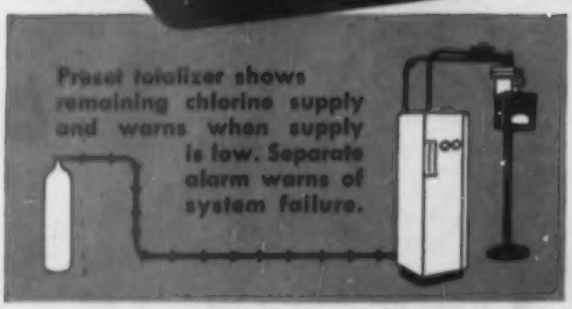

Continuous visual record assures efficient use of Chlorine

EFFICIENT USE OF CHLORINE puts money in your pockets. Comparison of chlorine and main line flow records provides a continuous safeguard against wasted chlorine or insufficient dosage by continuously monitoring the accuracy of the system.

This recording system is readily adaptable to most chlorinators of all manufacturers.

A simple screwdriver adjustment permits field synchronization of the flow recorder with the interchangeable capacity of the chlorinator. Indicators, totalizers, transmitters and high-low alarms are available for use in this F&P Chlorine Flow Recording System. These functions may be located remotely by the use of F&P pneumatic or electric transmission systems.

Every part is completely corrosion resistant. Magnetic coupling eliminates the need for trouble-making pressure tight bearings.

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DIG TRENCH LOAD SAVE

...with one fast-to-the-job Oliver!

Think of it! A *one-man* machine to handle all kinds of excavating and trenching jobs. That's exactly how cities across the country are cutting costs with the Oliver Super 88 Hydro-Trencher.

This advanced compact machine travels with rubber-tired ease over busy streets and work all those tight, awkward places. Yet, there is nothing small or limited about the variety of tough jobs it handles. There's a full 49.81 drawbar horsepower with six forward speeds.

With the ½-yd. Oliver 88 Hydro-Trencher, you're equipped for fast, continuous ditching or delicate line repairs. Powerful hydraulic down pressure, deep 12-ft. working range and 170° bucket rotation get jobs done in a hurry while savings mount.

Only Oliver gives you the bonus work value of *two* complete hydraulic systems on the Hydro-Trencher for amazing control and the ability to do any *two* operations at once without pressure loss. What's more, with Oliver's hydraulic stabilizer bar, you have the stability for full loads without any tipping tendency. For swing loading work, you merely turn around the same bucket. How's that for job versatility?

Whatever your digging and loading requirements, by all means investigate the Oliver Super 88. Your choice of gasoline or diesel engines. See your Oliver Industrial Distributor for a demonstration.

OLIVER

THE OLIVER CORPORATION

400 West Madison Street, Chicago 6, Illinois

a complete line of industrial wheel and crawler tractors and matched allied equipment

Water Testing

*APPROVED Water Pollution Control Technique

in the Laboratory

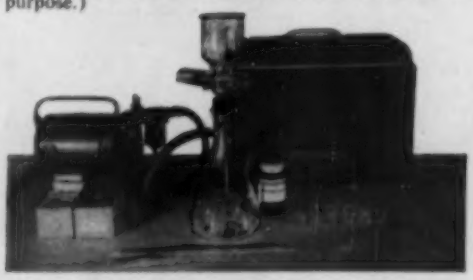
WHEN LABORATORY FACILITIES ARE AVAILABLE, and large numbers of samples from local sources are to be examined, it is recommended that conventional MF® laboratory equipment be employed. Dehydrated MF® Endo medium may be purchased from the Difco Laboratories, Detroit 1, Mich.; Baltimore Biological Laboratory, Inc., Baltimore 18, Md.; or Albimi Laboratories, Brooklyn 2, N. Y., U.S.A. MF® Endo media should be freshly mixed according to the manufacturers' directions. (Figure 1.)

Millipore Filters and Absorbent Pads are available in resealable Kraft bags. They should be properly autoclaved in the bags as received, for a period not to exceed 15 minutes at a temperature not to exceed 121°C. (Figure 2.)

ABSORBENT PADS ARE THEN PLACED IN INDIVIDUAL PETRI DISHES. Plastic Petri Dishes or ointment tins of the proper dimensions may be employed. Approximately 1.8 ml of Endo media is added to each pad (cover the dishes and put them to one side). (Figure 3.) Filters are placed on the filter holder base using alcohol-flamed forceps, and the funnel is centered and locked. (Figures 4 and 5.) A water sample of an appropriate size is then poured into the funnel and passed through the Millipore Filter into the filter flask by the aid of vacuum (Figure 6.)

The filter disc is then removed with sterile forceps and carefully placed on the absorbent nutrient pad in a petri dish with a "rolling action" to avoid trapping air between the filter and nutrient pad. (Figure 7.)

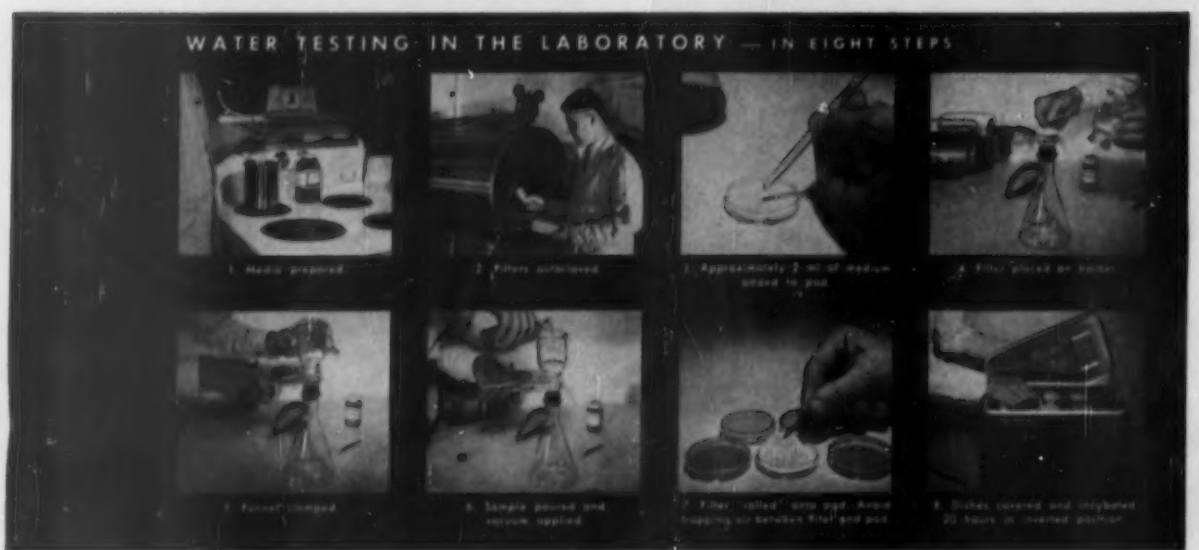
PETRI DISHES ARE INVERTED AND INCUBATED for 20 hours at 35°C. (Figure 8.) In potable waters it is not necessary to sterilize filter holders between samples. A 20 ml rinse of the funnel walls with sterile water is sufficient. (The water in the filter flask from previous filtrations may be used for this purpose.)



MATERIALS REQUIRED FOR 100 TESTS

Supplies: 100 (one pkg.) HA White Grid 047mm Autoclave Packed Filters. (Absorbent pads are included.)
10 grams Dehydrated MF® Endo Medium (or equivalent).

Equipment: 1Pyrex Filter Holder or Hydrosol Simplified Filter Holder. (Stainless Steel)
1 Vacuum Pressure Pump.
100 (one pkg.) Plastic Petri Dishes (or equivalent).
1 Field-Laboratory Incubator (or equivalent).
1 10 ml. pipette. 1 Pyrex Filter Flask (1 liter).
1 Pair Stamp-Type Forceps. 1 Magnifier 6X to 15X.
1 Field-Laboratory Incubator (or equivalent).



MILLIPORE FILTER CORPORATION

36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS, U.S.A.

Water Testing

*APPROVED Water Pollution Control Technique

in the Field

FIELD MONITORING KITS MAY BE CARRIED INTO THE FIELD to conduct studies of water pollution far from central laboratory facilities or to collect water samples for later analysis. A Field Monitor consists of a disposable plastic dish having a sealed-in Millipore Filter (MF®); there is also a Sampling Tube and an ampul of Coliform MF® Endo medium. All are sealed, sterile and ready to use.

The Sanitarian provides himself with a Sanitarian's Kit consisting of an all-metal syringe, valve, and sample cup. These need not be sterilized.

A SAMPLE OF THE PROPER SIZE IS TAKEN in the stainless steel cup. The cup must first be thoroughly rinsed in the same water from which the sample is to be taken. (Figure 1.) The syringe valve and sampling tube are plugged into the Field Monitor (they won't assemble incorrectly). The syringe plunger is drawn back and held to pull the sample up through the Field Monitor. (Figure 2.) Large samples may require several strokes. Monitors must be held upright to draw the last few drops from the filter. (Figure 3.) The plastic sampling tube is then removed and discarded.

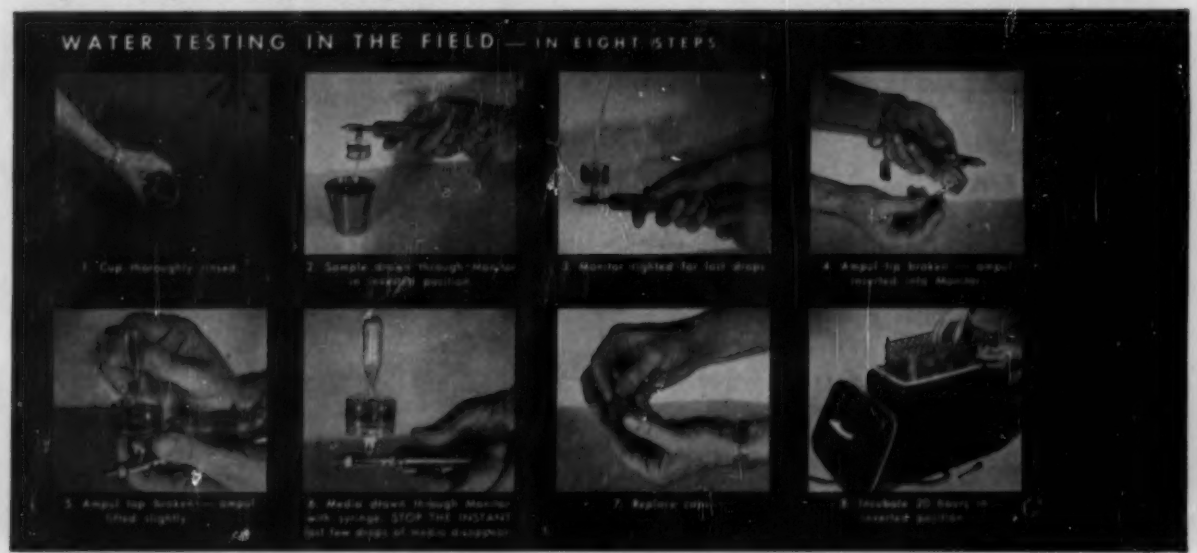
THE TIP OF AN AMPUL OF MEDIUM IS BROKEN and the ampul is inserted into the Monitor (Figure 4.) The top of the ampul is then broken and the ampul lifted very slightly to allow the medium to flow into the Monitor, (Figure 5.) A partial stroke of the syringe will draw the medium through the filter. (Figure 6.) It is important to STOP pulling on the syringe the INSTANT the last few drops of the medium disappear from the filter surface. The protective caps are then replaced. (Figure 7.)

THE FIELD MONITOR IS INCUBATED for 20 hours at 35°C. (Figure 8.) If desired, the Monitors may be replaced in their boxes and forwarded to a central laboratory for incubation. Special holding media may be substituted for Endo media if shipping delays over 48 hours are expected. Naturally, samples can be held for only short periods in excessively high temperatures (42°C or over). Some organisms will not withstand such temperatures whether in sample bottles or in the Field Monitor units. In an emergency, Monitors may be incubated in the field by placing them next to the body for 20 hours.

MATERIALS REQUIRED FOR 100 TESTS

Supplies: 50 MH White Grid 037mm DE Field Monitoring Kits.

Equipment: 1 Sanitarian's Kit.
1 Field and Laboratory Incubator.



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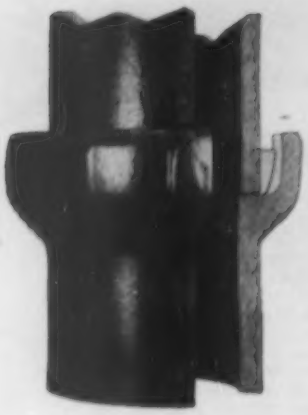
* Color illustrated booklet available.

Infiltration-proof AMVIT*-JOINTED CLAY PIPE gives you *lowest cost of sewer line in place*



Longer, stronger pipe with plastic mechanical joint speeds installation, saves labor

Amvit Jointed Clay pipe produces professional results with minimum effort. The joint is on the pipe, delivered to the job ready to use. No other materials such as caulking, joint compound, hot-pots, or ladles are needed to make the Amvit Joint. It takes just a few seconds to push the pipe together and the line is complete.

Field tests on the more than 60 installations completed show that Amvit prevents ground water infiltration. This results in sizable savings in both pumping and treatment plant costs. Amvit is a compression type joint on the ball and socket principle. Nothing can enter the line after it is complete.

Amvit Jointed Clay pipe, in sizes 4" through 24", together with all fittings is available for immediate delivery in the Northeast and Central States.

For more information, write or call American Vitrified Products Company, National City Bank Building, Cleveland, Ohio, or our office nearest you.

The Amvit Joint is made of a plastic material with rubber-like characteristics. Like the pipe, the joint will withstand the most severe underground conditions. Amvit Joint is furnished on all fittings.

SINCE 1900

AMERICAN

American Vitrified Products Company

CLEVELAND, OHIO

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Is *Water shortage* endangering the future of your community?

Badger Water Meters conserve present supplies by giving an exact accounting of usage and waste

Caught in a two-way squeeze between fast-growing population and booming industry, many communities suddenly find themselves with outmoded water facilities. The time to act is NOW if declining water supplies threaten the future of your community. Metering *all* water is the first logical step toward conserving present supplies . . . recording *where* and *how much* is used. Fair rates for all help keep water departments *self-supporting*. Safeguard tomorrow's water needs TODAY.

• For complete information on how metering can insure the future of your community, contact your Badger Meter salesman or write us direct:

Badger Water Meters

Water is Vital

Badger Meters have conserved it for 50 years

BADGER METER MFG. CO., MILWAUKEE 45, WISCONSIN

Can Your Water Pipe Withstand Three Times the Working Pressure?

As this chart shows, steel water pipe can withstand at least three times the calculated maximum allowable working pressure before bursting.

THEORETICAL INTERNAL PRESSURES OF STEEL PIPE

	1/4 in.			5/16 in.			3/8 in.			7/16 in.			1/2 in.		
Nominal Outside Diam. In.	Est Ship Wt Lb/Ft	Max Wrk Press Psi	Min Burst Press Psi	Est Ship Wt Lb/Ft	Max Wrk Press Psi	Min Burst Press Psi	Est Ship Wt Lb/Ft	Max Wrk Press Psi	Min Burst Press Psi	Est Ship Wt Lb/Ft	Max Wrk Press Psi	Min Burst Press Psi	Est Ship Wt Lb/Ft	Max Wrk Press Psi	Min Burst Press Psi
18	50	445	1390	62	555	1735	75	665	2080	88	775	2430	101	890	2780
20	55	400	1250	69	500	1560	83	600	1875	97	700	2180	111	800	2500
22	61	365	1135	76	465	1420	91	550	1700	107	640	1985	122	730	2270
24	67	335	1040	83	420	1300	100	505	1560	116	585	1820	133	665	2080
30	83	270	835	104	340	1040	125	405	1250	145	475	1455	166	535	1670
36	104	225	695	128	280	870	154	340	1040	179	395	1210	204	445	1390
42	116	195	595	144	240	745	173	285	890	202	335	1040	231	380	1190
48	132	170	520	165	210	650	198	250	780	231	290	910	264	330	1040
54				186	190	580	223	225	695	260	260	810	297	295	925
60				207	170	525	248	200	625	289	235	730	330	265	835
72							306	170	520	355	195	605	405	220	695
84							346	145	450	403	170	520	460	190	595
96	The recommended minimum wall thickness is approximately the pipe diameter divided by 165. Pipe having this diameter-thickness ratio, when backfilled and properly tamped, will withstand any depth of cover. For buried pipe, the recommended minimum wall thickness is shown immediately to the right of the heavy black line.									464	145	455	524	165	520
108													*605	150	465
120													*656	135	415

*Under certain conditions stiffeners may be required to reduce deflections.

$P = \frac{t \times Ts}{r}$ P = internal pressure, psi . t = thickness, in. Ts = allowable unit stress = 60% x 27,000 (yield point) = 16,000 psi

r = radius of pipe, in. Based on use of ASTM A-283, Grade B Steel, 50,000 psi min. ultimate tensile strength

Take a look at just two examples:

(A) If you select 36 x ¼ in. steel pipe, AWWA design standards allow a maximum working pressure of 225 psi, well in excess of ordinary pressures. Yet your *minimum* bursting pressure is 695 psi—over three times the working pressure.

(B) Now look at 60 x ⅜ in. pipe. With a maximum allowable working pressure of 200 psi you get a minimum bursting pressure of 625—that's triple, with plenty to spare!

Don't gamble with slim margins of safety. Don't take chances with water lines. Bethlehem Steel Pipe costs no more than other materials—actually *costs less* to install—and gives you reliable performance.

Remember, *every length of Bethlehem Steel Pipe is hydrostatically tested in accordance with AWWA standards, usually to twice the working pressure!* For further facts see the nearest Bethlehem sales office.

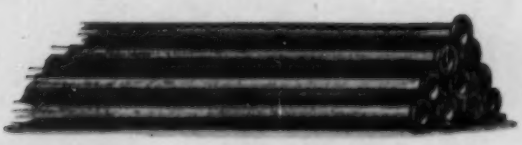
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

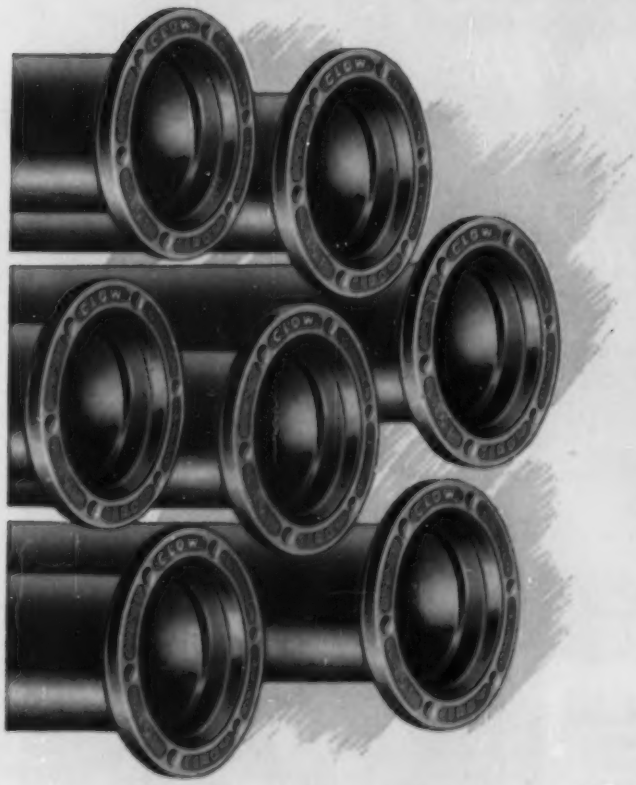
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

take advantage of the plus factors when you specify UNDERGROUND WATER PIPE





Experienced men who specify and install underground water pipe take advantage of the plus factors when they specify cast iron pipe.

Take the pressure plus factor. Minimum wall thickness Clow cast iron pipe (ASA A21.6 Class 22) is rated for at least 250 psi working pressure in diameters 10″ and smaller.

What does this mean? It means that cast iron pipe is rated safely above the minimum pressure requirements for municipal water service, and can be specified to the full ASA rated working pressure. This is because of the inherent strength of cast iron pipe . . . beam strength . . . compressive strength . . . bursting strength . . . all scientifically calculated with ample factor of safety on the basis of sound engineering practice and the result of actual service records.

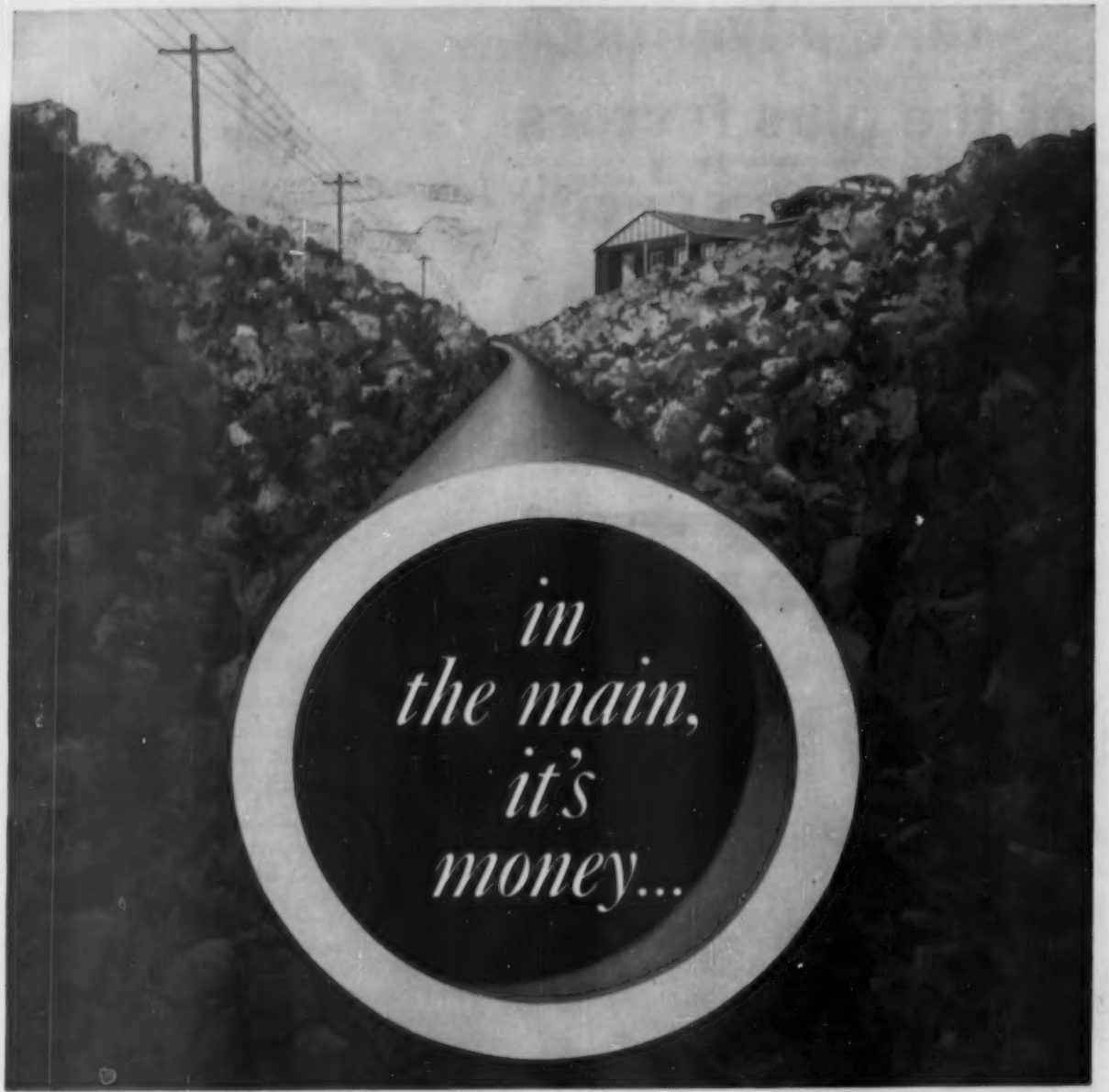
To get the best advantage of the plus factors for your system, invite a Clow man in to discuss your requirements when pipe first enters your plans.

JAMES B. CLOW & SONS, Inc.

201-299 N. Talman Avenue • Chicago 80, Illinois

Subsidiaries: Eddy Valve Company, Waterford, New York • Iowa Valve Company, Oskaloosa, Iowa

SINCE 1878



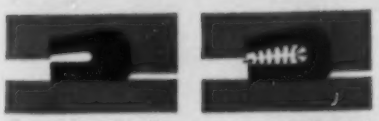
your tax money!

Non-tuberculating, non-corroding, non-electrolytic . . . these features of non-metallic K&M Asbestos-Cement Pressure Pipe mean low, stable pumping pressures and NO MAINTENANCE . . . Big tax savings for American communities!

But there are further tax savings in initial cost and installation with K&M Asbestos-Cement Pipe. It's light in weight, easily and inexpensively transported and handled. And K&M's EXCLUSIVE "Fluid-Tite" Coupling allows quick assembly under any weather conditions—*even with unskilled labor.*

Write today for complete information.

K & M "FLUID-TITE"® COUPLING



Compressible rubber rings allow easy pipe insertion.

Pressure expands rings. Higher pressure—tighter seal.

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ENGINEERS WANTED — Career opportunities open for men qualified in product development, machine design, automation, plant management, plant engineering and applied research. Write to Director of Engineering, Keasbey & Mattison Company, Ambler 5, Pa.

HORTON WATERSPHEROID

CHOSEN FOR ITS

Beauty and Ability to Supply Gravity Pressure Storage

City Council members of Sandwich, Illinois took these reasons into consideration when choosing a Horton Waterspheroid® for their city. At that time, the city was in dire need of ample water storage facilities and dependable, adequate water pressure.

The Horton Waterspheroid provides them with 300,000 gals. of elevated storage —a dependable gravity pressure water supply ready to meet normal and emergency water needs day or night— in a modern, pleasing structure.

Write Chicago Bridge & Iron Company for further information on the Horton Waterspheroid—or on other Horton elevated tanks.

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Chicago Bridge & Iron Company

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Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY *and* GREENVILLE, PA.

WORLD'S MOST

The Cast Iron Pipe Century Club...
Membership in this distinguished Club is restricted to water and gas supply systems still serving their communities through cast iron mains laid a hundred years ago... and more!

The Club's unique Honorary Certificate is earned only through performance. It is a tribute to the service supplied by these companies and to the carrier that enabled them to earn it... world's most dependable pipe... cast iron!

CAST IRON PIPE

UNUSUAL CLUB
adds 6 new members

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Niagara Mohawk Power Corp. (Gas)
ALEXANDRIA, Virginia
Alexandria Water Company
ALLENTOWN, Pennsylvania
Bureau of Water
*ATLANTA, Georgia
Atlanta Gas Light Company
BALTIMORE, Maryland
Bureau of Water, Dept. of Public Works
BALTIMORE, Maryland
Consolidated Gas Electric Light & Power Co.
BOSTON, Massachusetts
Public Works Dept., Water Division
BOSTON, Massachusetts
Boston Consolidated Gas Co.
BOUND BROOK, New Jersey
Public Service Electric & Gas Co.
BRIDGEPORT, Connecticut
Bridgeport Gas Light Company
BUFFALO, New York
Dept. of Public Works, Div. of Water
CHARLESTON, South Carolina
South Carolina Electric & Gas Co.
CHICAGO, Illinois
Peoples Gas Light & Coke Company
CHICAGO, Illinois
Water Works Department
CINCINNATI, Ohio
Cincinnati Gas & Electric Co.
COLUMBIA, Pennsylvania
Columbia Water Company
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Board of Water Commissioners
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City of Frederick Water Dept.
FREDERICK, Maryland
Frederick Gas Company, Inc.
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The Hartford Gas Company
HARTFORD, Connecticut
Water Bureau of the Metropolitan District
HUNTSVILLE, Alabama
Municipal Water Works
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Citizens Gas & Coke Utility
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Louisville Gas & Electric Co.
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City of Painesville, Gas District Dept.
PEORIA, Illinois
Central Illinois Light Company
PHILADELPHIA, Pennsylvania
Department of Public Works, Bureau of Water
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Philadelphia Gas Works Co.
PITTSBURGH, Pennsylvania
Bureau of Water, Department of Public Works
PLYMOUTH, Massachusetts
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Providence Gas Company
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SACRAMENTO, California
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Water & Sewerage Department
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North Shore Gas Company
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SPRINGFIELD, Illinois
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Water Div., Dept. of Engineering
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WHEELING, West Virginia
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CAST IRON

122 SOUTH MICHIGAN AVENUE, CHICAGO 3, ILLINOIS

Take the "sting" out of hydrant damage with DARLING QUIKFIX B-50-B's

HERE'S an unmatched combination for those locations where traffic mishaps are frequent. First, you gain all the unique advantages of Darling's standard B-50-B design, with its ball bearing operation and "O" ring seals. Easier, quicker operation . . . no packing gland maintenance . . . no water seepage to operating threads or bearings . . . no loss of lubricant.

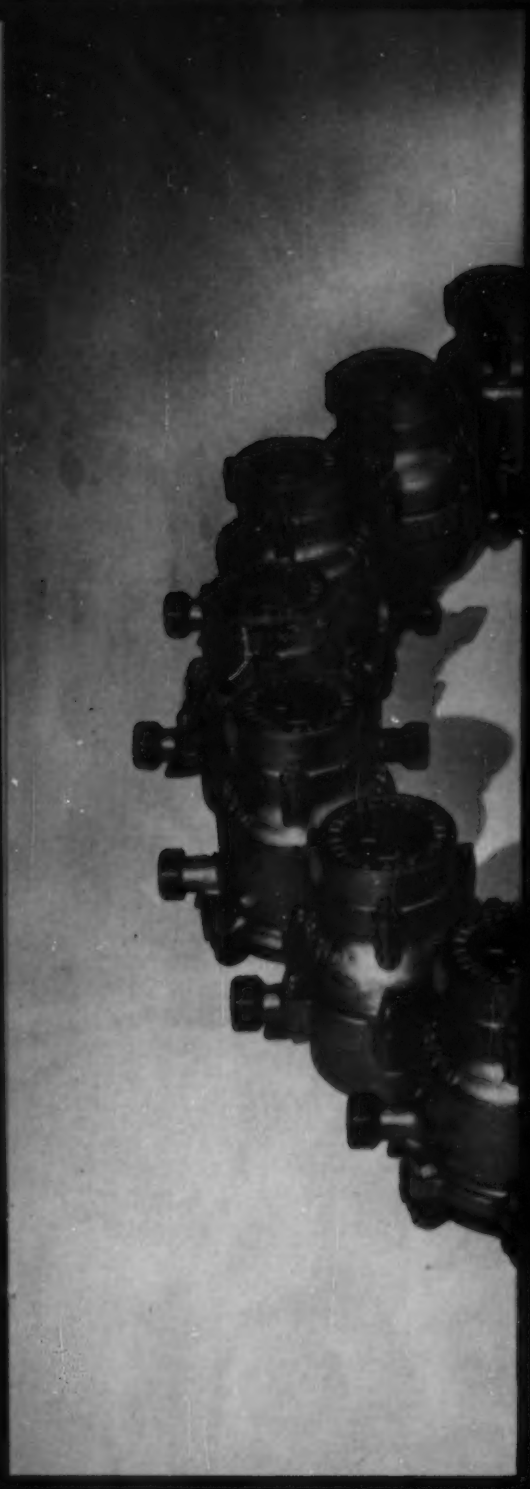
And when destructive impact does occur, Darling's improved breakable barrel and valve rod couplings "take the rap". Both hydrant barrel sections remain undamaged and intact. Moreover, on-the-spot repair is a quick cinch. Note how the barrel coupling is segmented—four pieces —for easiest, minimum part replacement.

Better get *all* the facts about Darling QUIKFIX B-50-B's and see how *much* you can gain and save. Write:

DARLING VALVE & MANUFACTURING CO.

Williamsport 11, Pa.

Manufactured in Canada by The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ont.



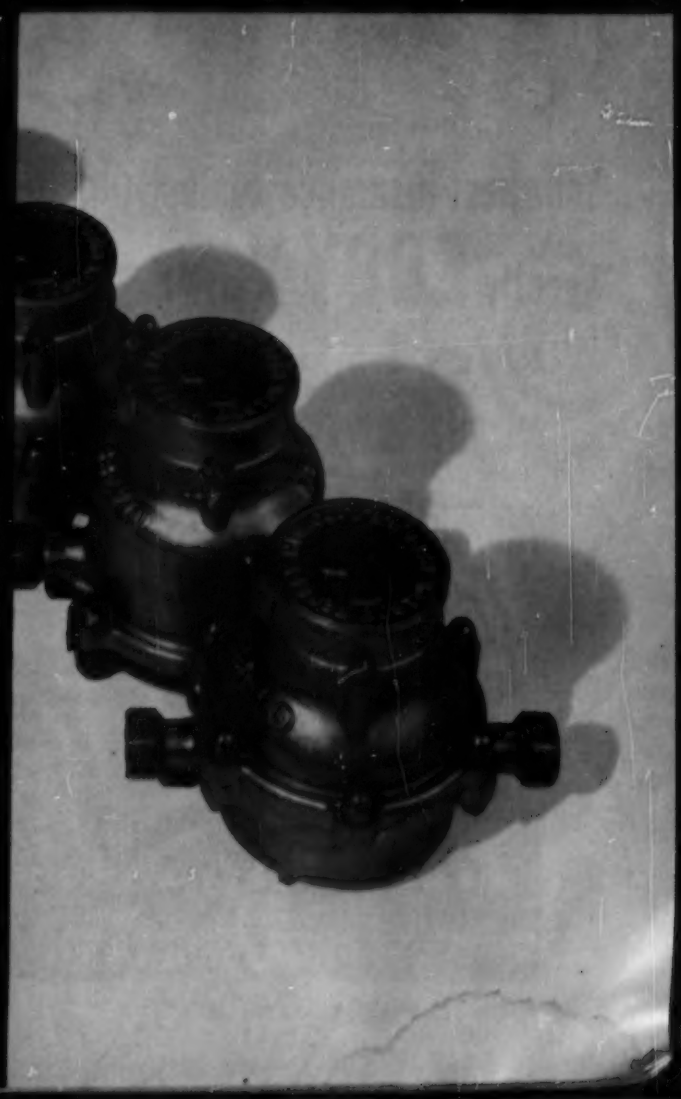
HERSEY

HERSEY WATER METERS

will give you the most for your money in accurate service and lowest maintenance cost.

First costs are very deceiving.

It's the maintenance cost that really counts.



HERSEY MANUFACTURING COMPANY

SOUTH BOSTON, MASS.

Branch Offices: NEW YORK — CHICAGO
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No matter how farsighted today's plans may be...

cities will grow old... in time

Famous "4 Corners," 1890— courtesy of Rochester, N. Y., Chamber of Commerce.

Your best insurance against obsolescence of your water system... specify EDDY Valves and Hydrants *throughout*

No matter how far into the future your city planning is projected, Eddy's record testifies that Eddy Valves and Hydrants are your best long term investment. Eddy Valve Company's more than 100 years of dependable operation means that, today, you can get replacement parts for any Eddy Valve or Hydrant ever installed. And our ability to continue to do so is your assurance against future obsolescence of your valves and hydrants.

EDDY Bronze-Mounted HYDRANTS open smoothly *with* the pressure and close without water hammer. One man can easily remove all operating mechanism for inspection and repair. Positive drip action automatically drains the standpipe, safeguarding against freeze-ups. Stem held in place below hydrant valve means that there is no water loss due to a bent stem.

EDDY Bronze-Mounted GATE VALVES offer simplicity of design, trouble-free operation and enduring service. From the engineering drawing boards through all stages of manufacture, they are step by step a truly "finished" product of workmanship. These factors, added to personal experience, tell why progressive water works men have relied on Eddy for generations.

Eddy Hydrants and Valves are available with hub, flange or mechanical joint connections to fit any existing or planned installation.

Send today for full data on the complete line of Eddy Valves and Hydrants. No obligation.

EDDY VALVE COMPANY

A Subsidiary of James B. Clow & Sons

WATERFORD, NEW YORK

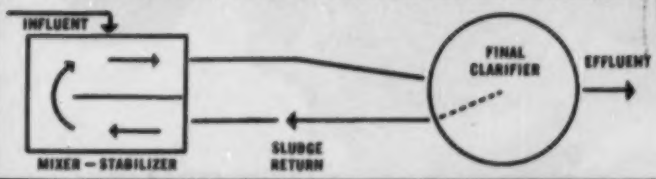
INFILCO *High-Rate* SEWAGE TREATMENT

twice as fast in half the space

Sewage plant of Washington County Sewer Improvement District No. 1, at Bartlesville, Okla., is compact and efficient with INFILCO equipment.

Engineering by Wood & Craig Consulting Engineers, Tulsa, Okla.

FLOW DIAGRAM: DESIGN AVERAGE FLOW 0.39 M.G.D.



Only 5 to 6 hours are required for throughput in the BIOSORPTION® high-rate activated-sludge treatment plant equipped by INFILCO—as compared to 10 to 12 hours for conventional equipment. Main components of the Bartlesville installation include a GRIDUCTOR® comminutor, a mixer-stabilizer with COLAFLEX® diffusers, WS clarifier and floating cover for digester. Overall results are excellent. Here are typical figures.

Period	Ave. Flow MGD	Average B.O.D. (p.p.m.) Raw Sewage	Final Effluent	% Removal	Suspended Solids (p.p.m.) Raw Sewage	Final Effluent	% Removal
1/14-2/3 '56	0.253	197	18	88.8	225	20	91.0

If your problem involves greater volume in less time from less space—*at lower cost*—consult INFILCO because INFILCO KNOWS HOW to help you solve it. Over 60 years of experience and the most complete and advanced line of equipment are available to you. Write today for full information on the interesting Bartlesville installation and Bulletin No. 6550.WS-25.

INFILCO

5085

INFILCO INC.
General Offices
Tucson, Arizona

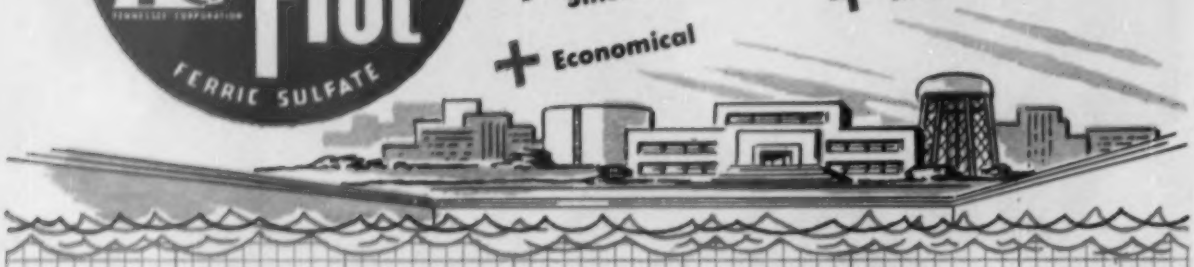
The ONE company offering equipment for ALL types of water and waste treatment.

FIELD OFFICES THROUGHOUT THE UNITED STATES AND FOREIGN COUNTRIES

Inquiries are also invited on all other water and waste treating problems including coagulation, precipitation, sedimentation, filtration, flotation, aeration, ion exchange and biological processes.

Ferri-Floc
FERRIC SULFATE

+ Excellent Taste and Odor Control
+ Rapid Floc Formation
+ Bacteria Removal
+ Manganese and Silical Removal
+ Economical
+ Coagulation Over Wide pH Range
+ Color Removal
+ Turbidity Removal
+ Ease of Operation
+ Increased Filter Runs



The Superior COAGULANT With the Plus FACTORS—

Ferri-Floc gives smoother, more efficient and trouble free operation. Whatever your particular water treatment problem may be, you can depend on Ferri-Floc doing a superior job and doing it efficiently and economically—Ferri-Floc is a free flowing granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy handling as well as storage in closed hoppers over long periods of time.

WATER TREATMENT

Efficient coagulation of surface or well water. Effective in lime soda-ash softening. Adaptable to treatment of all industrial applications.

SEWAGE TREATMENT

Ferri-Floc coagulates wastes over wide pH ranges — It provides efficient operation regardless of rapid variations of raw sewage — Is effective for conditioning sludge prior to vacuum filtration or drying on sand beds.

LIQUID SULFUR DIOXIDE
HIGHEST QUALITY
SO_2

SULFUR DIOXIDE

SULFUR DIOXIDE is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

COPPER SULFATE

COPPER SULFATE

COPPER SULFATE will control about 90% of the microorganisms normally encountered in water treatment more economically than any other chemical.

Available in: Cylinders, Ton Drums, Tank Trucks and Tank Cars

FREE BOOKLET

Let us send you without charge a 38-page booklet that deals specifically with all phases of coagulation.
Send postal card to—

TENNESSEE CORPORATION
617-29 Grant Building, Atlanta, Georgia

Rockwell Dual Unit Compound Meter Assemblies

EASIEST To Handle, Install, Service

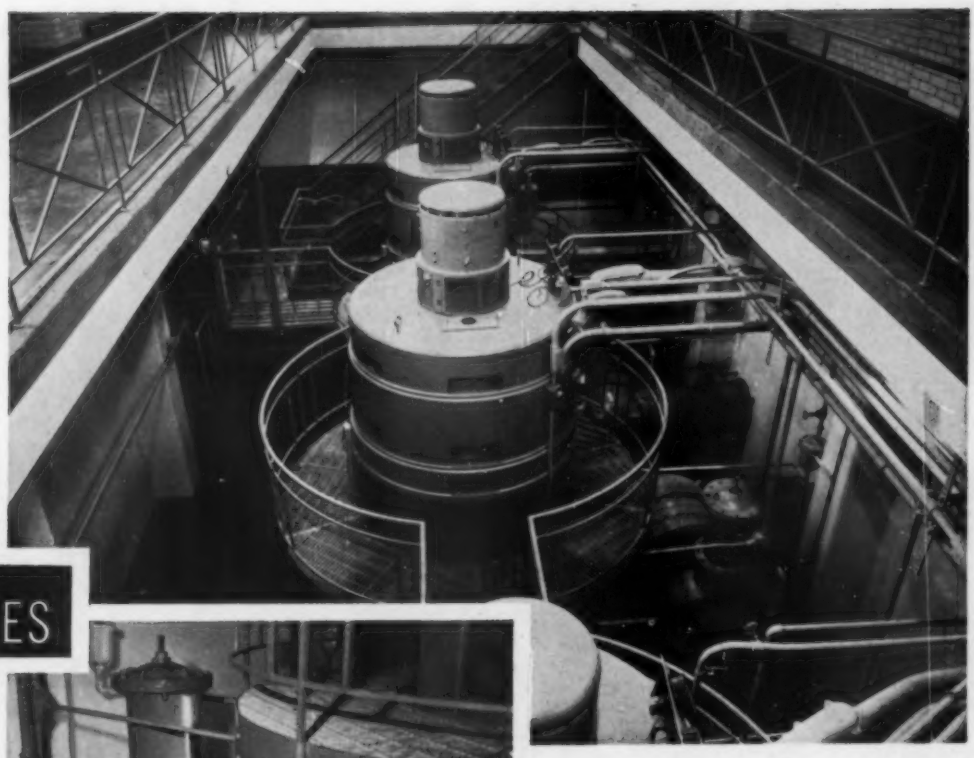
Big, bulky 8 in. compound meters are always a trial to install, even more of a problem to service. Now, with Rockwell—two meter single register compound manifolds you can save time and money. The complete assembly weighs approximately 100 lbs. less than a single big meter. Two men can handle it with ease. Maintenance of this Rockwell unit is a cinch. Either meter can be used to record off-peak loads while a new or repaired meter is being installed. And remember, Rockwell Dual Unit meter assemblies are razor sharp in the measurement department. They record *all the flows* with far greater accuracy than a single 8" compound. And they cost less. Write for latest bulletin.

ROCKWELL MANUFACTURING COMPANY

PITTSBURGH 8, PA. Atlanta Boston Charlotte Chicago Dallas Denver Houston Los Angeles Midland, Tex. New Orleans New York N. Kansas City Philadelphia Pittsburgh San Francisco Seattle Shreveport Tulsa In Canada: Rockwell Manufacturing Company of Canada, Ltd., Toronto, Ontario

ROCKWELL WATER METERS

A Size and Type For Every Kind of Service



SMS
ROTOVALVES

Ten hydraulically operated SMS-Rotovalves here range in size from 18" to 30".

Engineers: Greeley & Hansen, Chicago.

For the City of Niagara Falls, N.Y. . . .

SMS-ROTOVALVES SAFEGUARD HIGH AND LOW SERVICE PUMPS

SMS-Rotovalves were specified to safeguard service pumps in the City of Niagara Falls' new pumping station. Greater initial shut-off and positive control of closing time made them a logical choice to minimize water hammer in pump start-ups and shutdowns. Because SMS-Rotovalves have less pressure loss with a full line opening than other valve types, they save pumping power.

In addition to the SMS-Rotovalves, SMS Babbit-Seated Butterfly Valves meet the rugged, high service header requirements of fast, positive closure. At the adjacent filtration plant, 76 R-S Rubber-Seated Butterfly Valves were specified to give drop-tite closure, unusual economy of layout space and cut initial construction costs.

Whatever your application requirements, SMS has the experience and facilities to meet them. For additional information on our complete line of cone, ball and butterfly valve, see our local representative or write the S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines
Pumps
Gates & Hoists
Trash Rakes
Accessories

HYDRODYNAMICS

Rotovalves
Ball Valves
Butterfly Valves
Free-Discharge Valves
Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

AFFILIATE COMPANY: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Announcing

GOLD NUGGET

WELDED

grating

10,000 POUNDS

Realizing the need for an improved heavy duty open steel floor grating of greater strength and economy, The GLOBE Company presents GOLD NUGGET Welded Grating — the first grating to take advantage of modern engineering design. As a result of this improved design, the GOLD NUGGET primary load bar provides 22% more strength with 14% less weight. The primary load bar is a miniature I-beam with all of the advantages of a true structural member.

GOLD NUGGET Welded Grating is recommended for power houses, loading docks, oil refineries, fire escapes, drain grates, plating rooms, filtration rooms and for all types of heavy duty platforms.

GOLD NUGGET

- 3/8" projection weld nugget for greater rigidity and strength
- vertical alignment of the main load bars assured
- all bars are load carrying bars including secondary bars
- anti-skid pattern

For the complete details of this revolutionary new grating, write for new catalog today.

Distributors in all principal cities. Consult the yellow pages in your phone book under "GRATING."

PROJECTION WELD

Each secondary load bar (A above), as projected welded to the primary load bar (B above) has a shear strength of 5,000 pounds per weld. There are 18 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

The **GLOBE** *Company* MANUFACTURERS SINCE 1914

PRODUCTS DIVISION

SAFETY GRIP-STRUT GRATING · GOLD NUGGET WELDED GRATING · CABLE-STRUT AND GLOBETRAY CABLE RACEWAYS

4042 S. PRINCETON AVE., CHICAGO 9, ILL.

ALOXITE® underdrains solve filter problems for growing Barranquilla

Water consumption in Barranquilla, Colombia, jumped from 8.04 to 19.10 MGD between 1935 and 1950. This created quite a problem for the city's Empress Publicas Municipales. They tackled it by giving experts a free hand to investigate every method and material known in order to give Barranquilla the best water supply system obtainable.

Today Barranquilla boasts a brand new 12-MGD water filtration plant. And each of its three 4-MGD filter units is equipped with ALOXITE® aluminum oxide porous plate underdrains. ALOXITE underdrains were chosen because they have proved they can handle growing loads like those at Barranquilla with freedom from mudballs and with minimum loss of head. Complete backwashing is accomplished without upset beds.

All work on this outstanding installation was under the supervision of Dr. Samuel L. Hollopeter and Dr. Efraim Pereira, Director General and Chief Engineer, respectively, of the Empress Publicas Municipales.

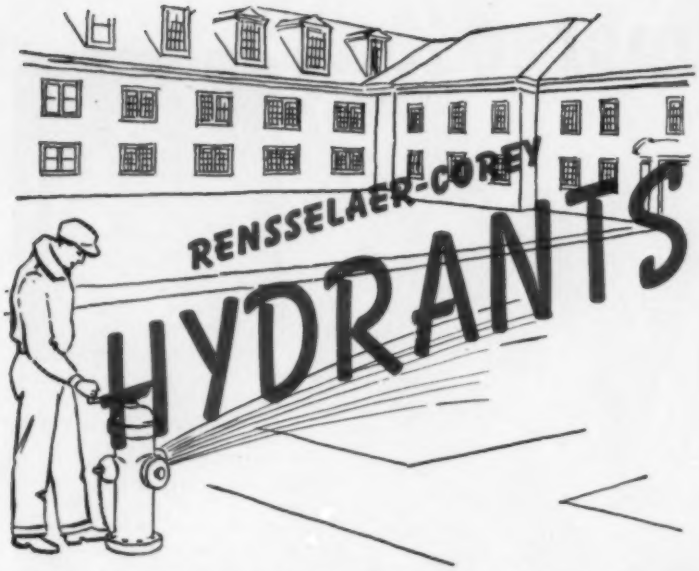
Answer your questions about porous media with Carborundum's 56 page booklet, "Porous Media." It's yours for the asking. Just write to:

CARBORUNDUM

Registered Trade Mark

Dept. X17

The Carborundum Company, Perth Amboy, N. J.

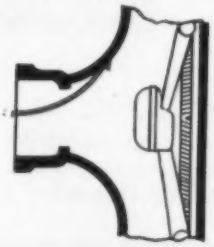


This is the hydrant that has been the standard of excellence in hundreds of cities for many years. Inspectors, maintenance men and fire chiefs, all have their reasons for endorsing the Rensselaer Corey Hydrant.

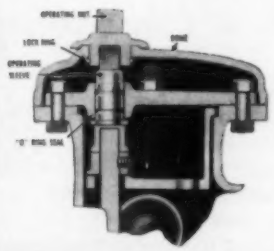
The illustrations show the clear-flow design which insures low head loss and maximum flow. Maintenance men like the simplicity of design and the speed of removing, inspecting and replacing the working parts as a single unit.

This hydrant opens with the pressure, is easy to operate and cannot stick. No digging for repairs, or for standpipe breakage. Now available with any type connection and "O" Ring seal.

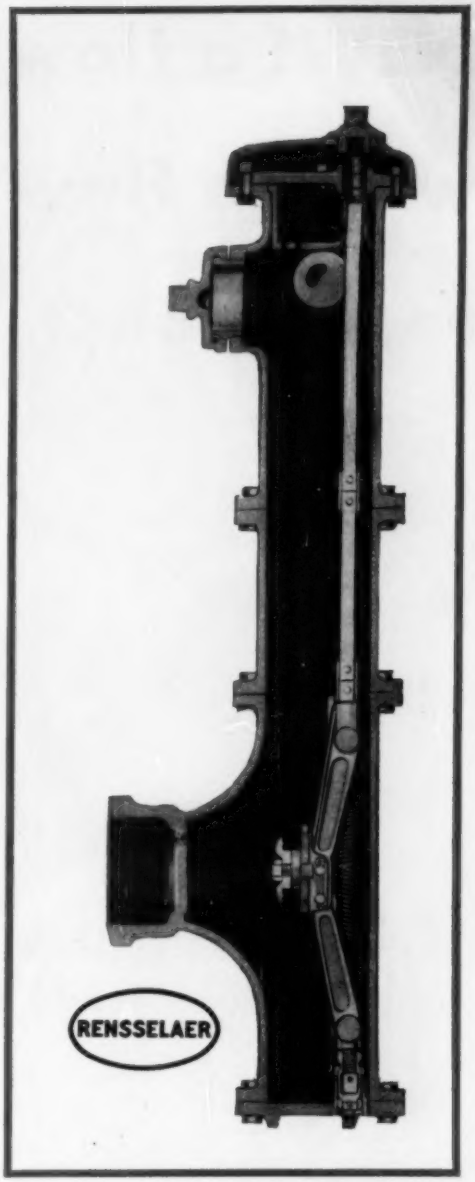
18



CLEAR FLOW
LOW HEAD LOSS



HYDRANT HEAD
WITH "O" RING SEAL



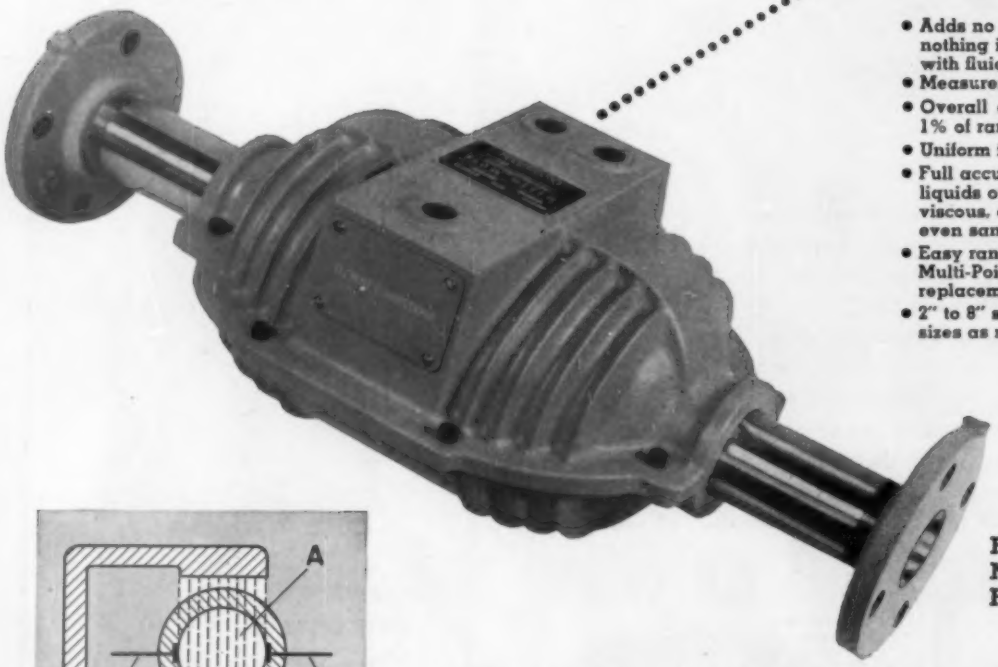
Ask for Bulletin "G"

LUDLOW & Rensselaer

LUDLOW RENSSELAER **VALVES & HYDRANTS**

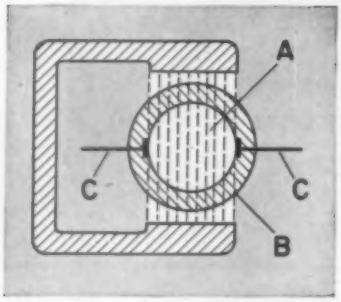
Since 1861 **THE LUDLOW VALVE MANUFACTURING CO.** *Troy, N. Y.*

NEW! a flow meter with no flow restrictions!



- Adds no pressure drop — nothing inside pipe to interfere with fluid flow.
- Measures fluid velocity directly.
- Overall accuracy better than 1% of range over entire scale.
- Uniform flow scale.
- Full accuracy sustained even on liquids other meters can't handle: viscous, corrosive, or pulpy — even sand-water slurries.
- Easy range change — either by Multi-Point Switch or range coil replacement, as preferred.
- 2" to 8" sizes standard — larger sizes as required.

FOXBORO MAGNETIC FLOW METER



SIMPLE, TROUBLEFREE, OPERATION

The Foxboro Magnetic Flow Meter operates on the same principle as a power generator. A magnetic field (A) is maintained through a standard pipe section (B) of stainless steel or other non-magnetic material. This pipe section is lined with Kel-F® or other insulating material. Liquid passing through pipe acts as moving conductor, generating an electric voltage which varies in proportion to liquid's average velocity. Flush electrodes (C) in pipe wall "pick up" this voltage which is recorded in desired flow units by Dynalog Electronic Recorder or Controller.

This premium-performance meter measures *magnetically* the flow rate of virtually any liquid except hydrocarbons. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density, and viscosity. It even measures reversing flows.

Installation is simple. The magnetic spool piece connects into the line like any equivalent length of pipe — no seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Electronic Flow Recorder.

Maintenance is practically eliminated. There are no pressure taps to become plugged or frozen, no working parts to foul.

Foxboro Magnetic Flow Meters are already in use on such widely different liquids as beer, sand-and-water, rosin size, rock-and-acid slurry, viscose, and highly corrosive liquid detergent. Find out how this precise, troublefree flow meter can help *your* processing. Write for complete details.

THE FOXBORO COMPANY, 891 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

Foremost in FLOW METERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

PFT Floating Covers and Waste Gas Burner eliminate odor nuisance at Conshohocken.

At Conshohocken, Pennsylvania . . .

Sewage plant next to residential area eliminates odor with modern PFT equipment

In planning their new sewage treatment plant (completed 1954), Conshohocken's engineers faced a special housekeeping problem: the nearest taxpayer's home would be 100′ from the digesters. To avoid any possible odor nuisance, the city adopted PFT equipment for "Controlled Digestion" which now operates harmoniously in a residential area.

The two 50′ digesters are equipped with *PFT Floating Covers* for positive scum submergence and safe utilization of gas. The snug fitting covers eliminate odor problems and reduce explosion hazards—gas collected under the dome is maintained at positive pressure under all operating conditions. Capacity is highly flexible because no fixed levels need be maintained; covers simply rise or lower with additions and withdrawals.

In the well planned Control Room are (1) PFT Heater & Heat Exchanger, (2) six PFT Gas Pressure Gauges, (3) two Supernatant Selector & Gauge units.

As further protection from odor, a *PFT Waste Gas Burner* (see illustration above) safely burns all excess gas produced in the digesters.

The plant's heating system is equally modern. A *PFT Heater & Heat Exchanger* (500,000 B.t.u. per hr.) maintains close temperature control of the digesters *automatically*. Fired by gas *or* oil, it cuts fuel costs by utilizing all gas produced in the digesters.

Additional PFT equipment installed for "Controlled Digestion" includes: two *Supernatant Selector & Gauge* units, two *Floating Cover Gauge Boards*, a complete set of *Gas Safety Equipment*.

Congratulations to Conshohocken —another good example of how a well-equipped plant can become an agreeable neighbor.

Design of plant by / *Albright & Friel, Inc. Philadelphia, Pa.*

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In Plattsburgh, N. Y., the story was different. Wasteful habits were causing water shortages, so Plattsburgh decided to install water meters. As a result, they "found" 1,400,000 more gallons daily . . . enough to supply a new Strategic Air Command Base now located there.

Even communities who have had meters for many years . . . but have allowed them to run down . . . can "find" more water simply by repairing the meters.

These savings are *real*. The meters give a strong money incentive for conservation. They help keep wells and reservoirs from running dry. The same filter plants and water mains may serve up to twice as many customers . . . with lower daily operating costs.

Your Neptune Trident meter representative will be glad to offer further evidence.

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WATER & SEWAGE WORKS

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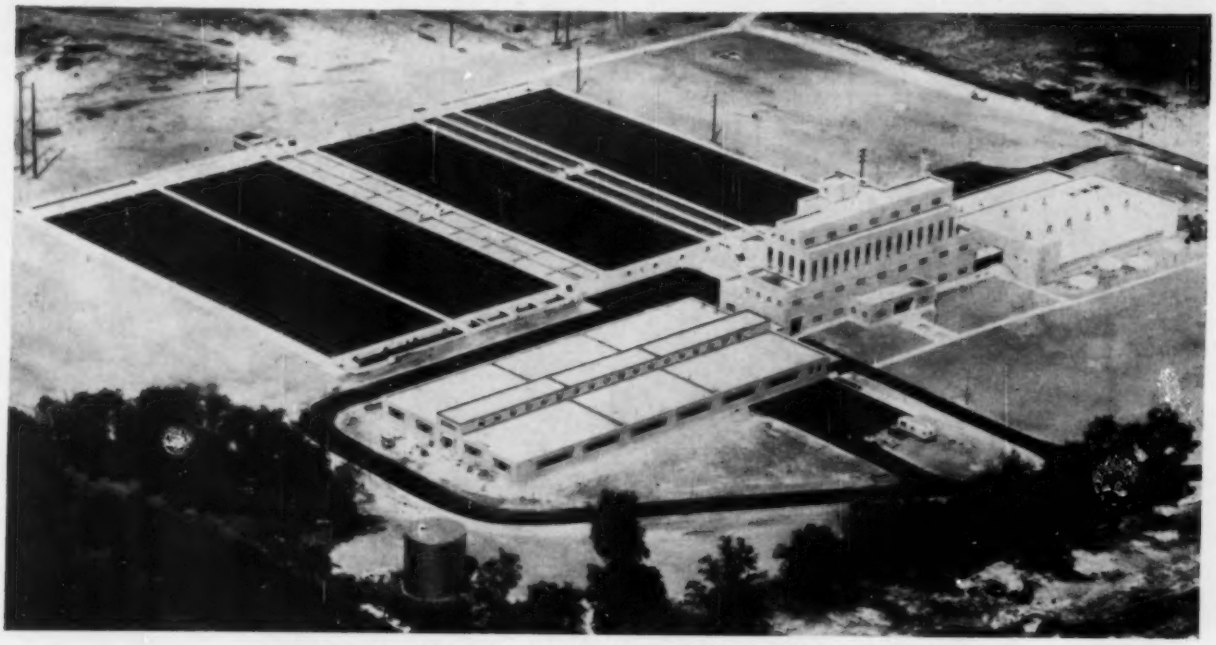


COLUMBUS, Ohio's New Walnut Creek Water Treatment Plant

Water Supply Progress in 1956

A review of developments and trends of the year in water supply

by FRED MERRYFIELD*

The author of this excellent review is Professor of Sanitary Engineering at Oregon State College, Corvallis, Oregon. He is also a partner in the engineering firm Cornell, Howland, Hayes & Merryfield of Corvallis, Ore. and Boise, Id.

*Currently Fred Merryfield has the distinction of being president-elect of the American Water Works Association.

BEFORE me lies a large collection of notes gathered from various sources, all relating to water supply. Gathering these has been no small task and yet it is quite evident that, while these may represent in words part of the vast human activity in this field in the U. S. and Canada, they by no means (even if all the writings on the subject in 1956 were evaluated here) still do not represent the interest, ingenuity, devotion and work of the vast group of men who daily, in some manner, directly or indirectly, are serving the public with water twenty-four hours a day, three-hundred and sixty-five days a year. This paper, then, can only be a "spot sample" of such progress and effort.

Our complex social, industrial, agricultural, and economic life depends on so many variables that, even with our physical, biological, and sociological understanding and our mathematical ingenuity, it is difficult to set forth their relationships and solve them in our most modern computer devices.

To name a few of these complex variables; the direction, amount, and timing of a suburban development; automatic controlling of pumping stations for effective regulation of flow and pressure; surge prevention; the multiple uses of water today and the myriad of laws controlling them; the

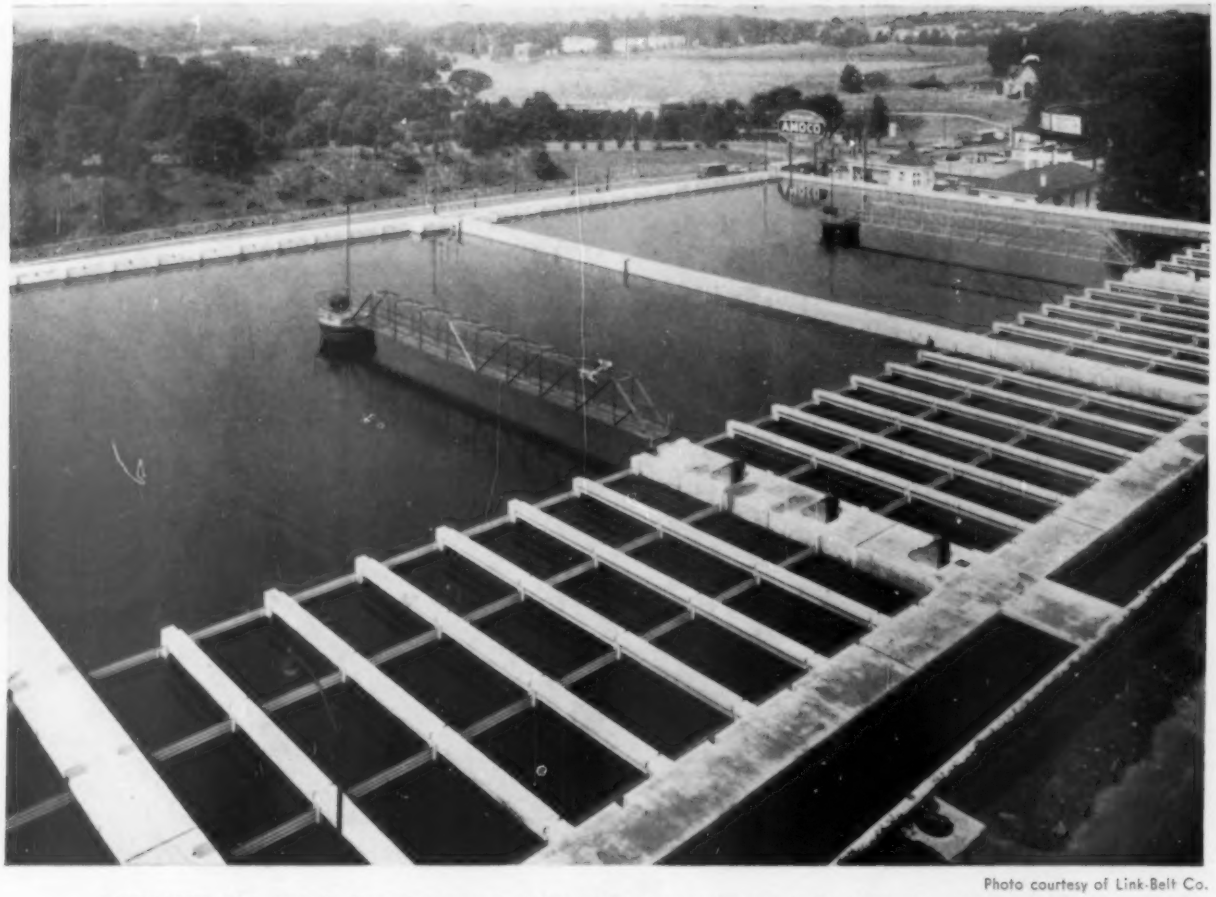


Photo courtesy of Link-Belt Co.

BALTIMORE, Md., installs flocculation and sludge collection equipment in its Ashburton Filtration Plant

productivity of a watershed by land and water use; the complex phenomena of corrosion and the effect of dissolved and suspended solids in high pressure boilers; fair and equitable water rates; methods of disposing of nuclear wastes; the intricate relationships between rainfall, temperature, humidity, wind and runoff; and, added to all of these, the most complex of all relationships—*the customer*.

What was theoretical and visionary yesterday is common practice today. Time is not very distant when pH, saturation index, MPN, polyethylene, chloramine, microfilter, and radioactivity were words used in the laboratory or classroom. Laymen were dubious or awe-inspired at the verbal enunciation, and time is not so distant in the past when some of these enunciators tended to stay in their ivory towers and not communicate with the multitude. But now there in no thirty-year lapse between the evolution of the scientific thought and its application to a practical problem.

As to Sociological Progress

Time has collapsed, and the boundary between science and the practice of it is not too clear. War alone has not caused this and, man, through the use of power, education, and social advancements is demanding these material improvements—and, also note, this man is *the customer*. This customer—about whom we know more today than formerly; and, incidentally pay more attention to,—is as complex an animal as you and I. He has his fears and courage; his hatreds and his loves; his cynicism and his belief; his simpleness and his erudition; and, his greed and his generosity. This man is your boss—be you a manufacturer, superintendent, engineer, salesman, operator, editor, or teacher.

This man needs education in the field of facts. We note some progress in this, when during the year a Board of Water Commissioners publicly congratulated a group of their own engineers who had brought honor to themselves and their city by winning a coveted prize for an excellent paper on a phase of water supply. Progress is reported by AWWA's "Willing Water" in every issue during 1956. In this useful publication are reproduced excellent examples of public information on water supply problems given by various water utilities to their citizens. And, we were also privileged to hear a stirring address by counsellor John Murdoch at the St. Louis Diamond Jubilee of AWWA titled, "Seventy-Five Years of *Two* Cheap Water", it carried the appropriate quotation, "The fault, dear Brutus, is not in our stras but in ourselves, that we are underlings".

The most difficult group to educate are the most vociferous. There are still abroad in our world many of those who believe all mountain and ground waters are pure and free, that any chemical added to such waters is a plot against mankind, and that water charges are just another form of taxation. Patience, explanation, and still more patience is needed in our dealings with them but even though you hear them they are not, fortunately, the voice of the general public. To this larger group, we must tell the story of our work factually but dramatically. Again AWWA is helping, now with publicity attendant to section meetings, and later we hope with other methods. Progress in this field of human relations may be slow, but definitely worth the effort.

Photo courtesy of Wiley & Wilson Engrs.

"PLANT OF THE YEAR"—Lynchburg, Va's, novel all-gravity filtration plant with filters on the sixth floor (see story Sept. 1956 W.&S.W.)

As to Technical Progress

It is much simpler to report of progress in the technical and scientific phases of the industry. Advances in purification and treatment of water and in the physical development of water systems are identifiable and measurable. Some aspects of management are more easily discerned and evaluated than others.

Apart from these, however, there is one happy circumstance of which all members of the water works industry had reason to be proud, namely 1956 was the 75th Diamond Jubilee year of the American Water Works Association. This was the key-note of a colorful conference celebrated "at home" in St. Louis (birthplace of AWWA) replete with congratulations from other associations and societies in this country and abroad. Noteworthy, were the excellent papers and discussions, unusual entertainment, and a closing banquet decked with flowers flown in by members from Hawaii.

Management

Reference has already been made to the fact that water is "too cheap" and for seventy-five years has been so because of our own philosophy and lack of salesmanship. Paul Weir, emphasized in his presidential banquet address at the AWWA convention that the water consumed by the public today is not a natural product but a manufactured product requiring the highest skill to produce and deliver.

L. R. Howson, a past president of AWWA, has brought out some telling factual arguments against "too cheap" water rates. The old idea that a minimum charge of $1.50 per month is adequate cannot be sustained. He notes that more than one-half of all the residents in nearly all cities use less than 3000 gallons per month. The monthly allowance for the minimum charge should be something less than 2000 gallons per month. Three thousand gallons per month allowance offers no inducement for conservation, or reasonable use. An increase of a penny per person per day would increase residential revenue by more than 50 per cent. Similar increases for commercial and industrial rates would produce sufficient revenues for most plants. Howson concludes that good water service requires good management which studies water needs in advance, provides expansion, coordinates construction and financial programs, and acquaints the public with the financial requirements and adequate revenue to provide requisite facilities before an emergency develops.

In contrast with gas and electric utilities, for too many years water utilities in general have been living on a minimum basis, developing and expanding the supplies when confronted with a crisis, often under ineconomic conditions, underpaying those faithful employees who stay with the utility, and charging customers for water based on rates not adjusted to present day conditions. We should do better in 1957.

Henderson notes the change in water use on the Atlantic seaboard in twenty years. Originally, the controlling factor of design was fire while now he notes a 10:1 to 4:1 range in the maximum hour over the annual average. The amount of water sold per year during the periods when the peaks are more than four times the average consumption will produce

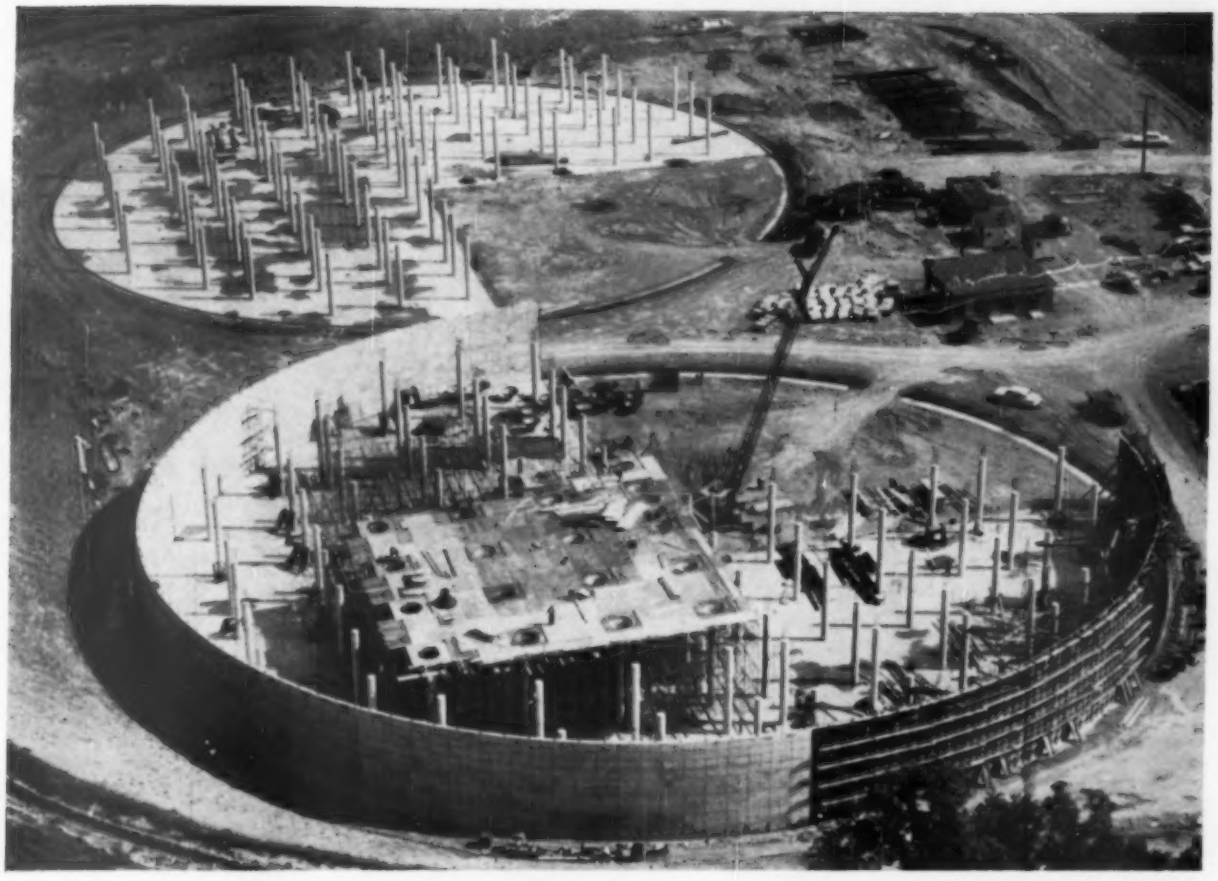


Photo courtesy of The Preload Co.

READING, Pa., adds two 13 mg. (292' diam.) reservoirs of pre-stressed concrete construction

but one-sixth the revenue necessary to meet the fixed charges. He suggests financing and rates to meet this situation.

Amsbary, in a round table discussion on air conditioning and water supply, suggests a water demand charge. The shape of the water use curves for irrigation, industrial, and air conditioning has been developed by Hatcher. Such curves indicate the severity of these demand problems and are used as the basis of a demand charge in the Kansas City rate schedule.

Finch and Tanghe have each made excellent studies also on this all-important matter and recognize, as does Hatcher, that larger lots in suburban areas, home ownership and pride of home and grounds, and light and heavy industry are mainly responsible for these ever increasing demands by customers able and willing to pay.

Kempton, of Trenton, Missouri, suggests that adequate ordinances are required to control air conditioning. These ordinances should (1) place complete control of the waterworks with the superintendent, (2) provide for inspection and issuance of permits which are revocable, (3) provide safety measures as to sanitation and electrical connections, (4) provide rough demand rate based on monthly water use, and (5) provide penalties for infractions.

Meterization

Important as rates and demands are, of equal importance is the measurement of the water delivered. Patten, Smith, and others have stressed the importance of sound metering practices. Santa Monica, for example, is determined to reduce its "unaccounted for" water to 3 per cent. Sound meter maintenance and leak reduction in reservoirs and mains have already reduced the losses to 7.2 per cent. All water service lines are being changed to copper. The increased revenues exceeded the costs of this program after the first year of operation. Like Philadelphia, Minneapolis is reported to have embarked on a program of acquiring 114,000 meters now owned by its consumers and eventually testing, repairing, and replacing practically all meters. Philadelphia is doing a masterful metering program and is the first known publicly owned water works to adopt an incentive pay plan to boost meter-shop performance and economy.

We listened recently to a water superintendent who gave a lecture at a meeting in Missouri on "Meter Care, and Revenue Losses" that must be heard to be appreciated. My reaction was to hurry home, jerk out my water meter, and have the offensive thing's heart examined and pay my water bill.

Lacking a meter test program, New York reports a loss of $3,000,000 annually from underregistration particularly of 1-½" meters and above. A program of meter testing has been suggested for meters of 2" and larger.

According to a recent article, President Weir of AWWA might be found scooting around Atlanta trying out a three-wheeled all weather motor scooter. This device, with a human attached, makes curb meter reading a faster and pleasanter occupation in residential areas. There has been no report as yet on the reception given to these devices by the casual population of Georgia's capital.

In addition to rates and meter maintenance, management must consider billing as well. The cash register, like the Model T, has had more than its

Photo courtesy of Graver Water Conditioning Co.

MISSOURI Water Co., Independence, Mo., in record time completed a new 6 mgd. treatment plant, employing "super-saturation lime softening" in slurry contact units

face lifted. Winnetka, Illinois, reports a model that checks the arithmetic of the operator and refuses to budge if the answers do not tally.

Safety Practices

Safety practices in the waterworks industry have been examined and reported on in a Labor Department survey and the Safety Practices Committee of AWWA has published a "Safety Manual". Through papers and discussion, this problem, neglected by many in the industry, has been, particularly in the last few years, brought to the attention of management and personnel. Committees are being established throughout the country to develop more active interest in this matter. This forward step cannot help but prove beneficial. An excellent list of incompatible chemicals and a bibliography of Safety Information Sources have been published. Numerous water utilities are practicing improved safety and publishing the results of their achievements.

A continuation of the City-County type of water development is reported in Georgia in the creation of the Cobb County-Marietta Water Authority. This Authority can sell water also to neighboring counties and has the advantage of the use of revenue bonds. Chicago, Milwaukee, and other cities, large and small, are looking far into the future and are developing equitable solutions in the future physical and financial development of the water system to keep pace with the growing demands. Other cities such as Vancouver, Winnipeg, Baltimore, and Los Angeles, some of them pioneers in metropolitan thinking, have related their recent experiences. Several of the state legislatures have this year conducted hearings through interim committees to examine all the facets of suburban area expansion. Water supply, waste disposal, gas and electric service, and transportation are probably the most difficult and complex legal, economic, and financial problems facing the public of the U. S. and Canada today. Certainly the states and counties, and cities and private industry together should vigorously pursue this matter in all its ramifications.

In certain sections of the country, notably where there are large concentrations of populations and large water supply reservoirs, there are sharp differences of opinions on the use of reservoirs for recreational purposes. It is quite apparent that this problem has no simple solution or single equation which will answer all local or regional areas. The City of Seattle is now engaged in serious debate with recreationists on public admittance to the City's watershed. Forces are gathering at State levels, it is believed, to force the opening of public water supply reservoirs and watersheds to the public admittance. The problem is here, but not resolved.

A very interesting article in the July 1956 issue of this magazine describes the intentional fish kill in San Diego's Hodges reservoir. The authors indicated that in earlier days there was little or no control of the dumping of minnows by bait fishermen. The results were eventually a large carp population, which in their bottom feeding riled the waters of the lake and the temper of the superintendent who took, with considerable

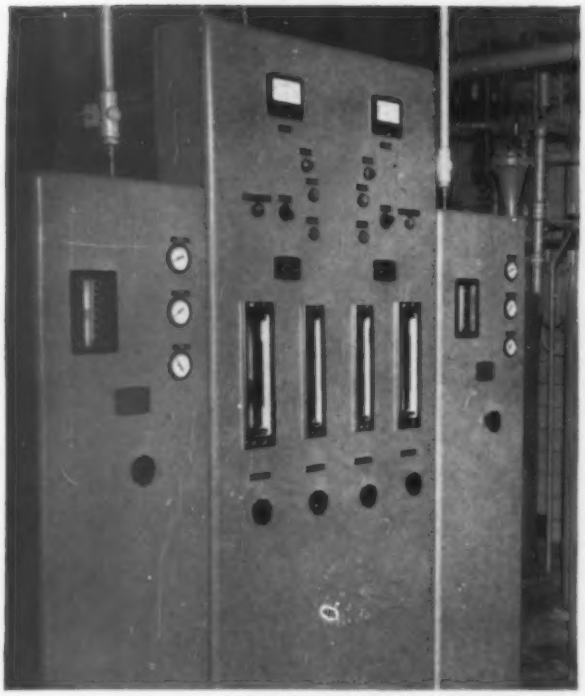


Photo courtesy of Omega Machine Co.

OMAHA, Neb., installs a Continuous Silica Activator for activated-silica production as coagulant aid

Photo courtesy of Fischer & Porter Co.

CHLORINE distribution panel with "Rotameters" and high capacity chlorinator, Washington Suburban District's new Patuxent Filtration Plant (see cover picture)

help, and a compound with a rotenone base, a total of 106.8 tons of killed carp from the lake. Some of the large carp were unobliging at first, but floated to the surface a few days later. These were also removed. Unfortunately, other fish than the carp had to be destroyed also.

Water Resources and Water Law

The far-sighted members of the water works industry have always been interested in the general problem of water resources development. In some areas in the country, particularly in the seventeen semi-arid western states, there has been naturally more concern over national water policy and the problems of multiple use. National water policy committees and commissions, and engineering societies have for several generations been rendering reports on the place of Federal, State, and local governments and the individual in this picture of water rights, water policy, and water development. Due to the scarcity of water in these western states, the waters of many of the rivers have been adjudicated by the State Courts, setting up precedents which created many modifying or enabling statutes and establishment of prior uses. For more than seventy-five years, this body of western water law has been built up.

Some of the most outstanding of our water supply engineers have served on one or more water policy committees, but in general, the water superintendent and engineer of the humid areas have been, until recently, unaware or indifferent to the legal aspects of water rights and to the competitive uses of water. Apart from the larger metropolitan areas, the amounts of water used domestically are relatively small when compared with industry and irrigation. Since the war, industrial and suburban expansion, improved standards of living, increasing populations, realization of the value of supplemental irrigation for farms and lawns by the rest of the country, and droughts in some areas have created situations where even the smaller towns are scratching in some places for enlarged sources. The result has been the creation of state water resources boards and commissions with all kinds of power or lack of powers.

Added to this complicated situation are the two legal doctrines of water rights, namely "riparian rights" and "beneficial use". The latter is embraced entirely, or in good part, by all of the seventeen western states, while the former doctrine prevails in the remaining thirty-one states. In the last few years, the Supreme Court of the United States has rendered judgments concerning the water rights of the individual states. Where the Federal Government owns large sections of a State, these decisions have presented legal water problems far too complex to elaborate on here, even were the writer a "water rights" lawyer. Bills, attempting to clarify the Federal and State ownership of waters, were stranded in Congressional Committees in 1956. Meetings of state government representatives, city groups, engineering, recreational, and reclamation organizations have made this an unusually active year in the legal phases of water resources development. In this, there has been too little interest shown by water works men on the whole.

Management of water utilities needs to inform itself and participate in these activities. While there is plenty of water, it is not well-distributed, seasonally or geographically. Gross figures of water availability in no way tells the story. The water superintendents' concern is the availability at the customer's premises. Far-reaching discussions and decisions on water allocations and water laws are to be made in the not too distant future, maybe in the 1957 State Legislatures. It has been, and still is, the writer's belief that profligate use of water, in municipal, industrial, and agriculture fields will be subjected to review, research, and action some day.

It is probable that research in

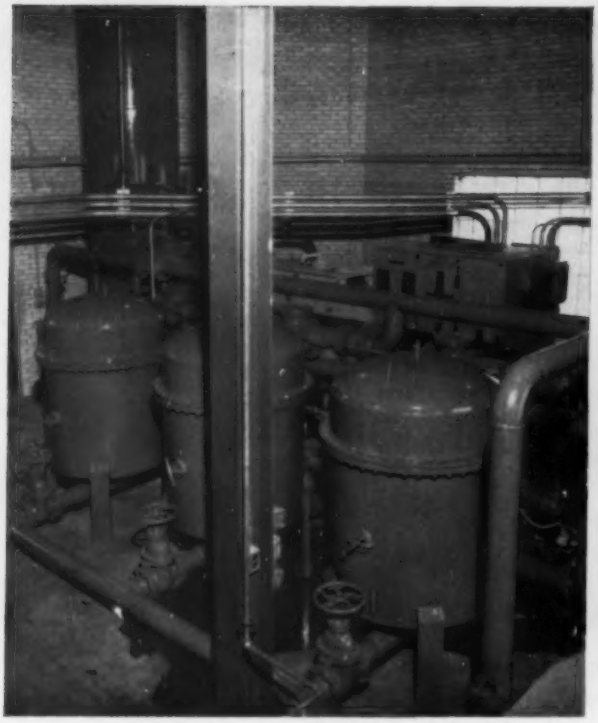


Photo courtesy of General Filter Co.

DIATOMITE filters are a fast and economical "package job" for small municipal water purification plants

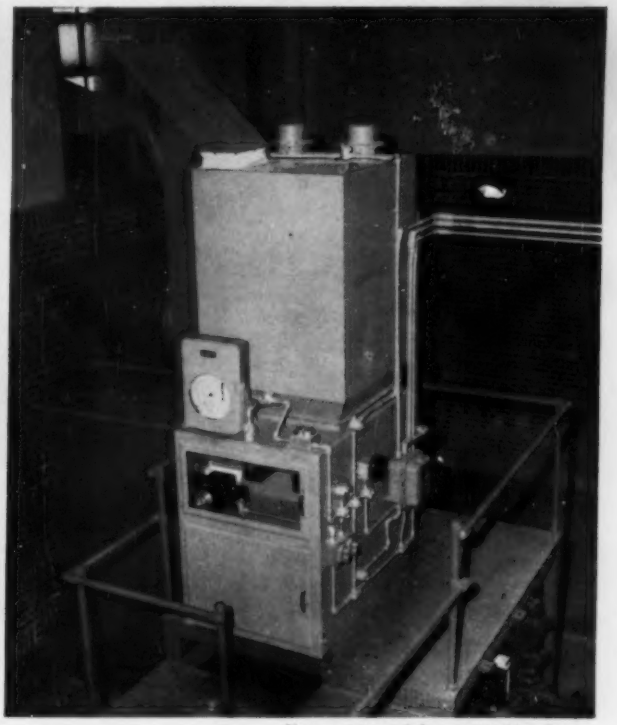


Photo courtesy of Omega Machine Co.

FLUORIDIZER at Cleveland, Ohio, feeds sodium silicofluoride by loss-in-weight system of control

weather modification, artificial ground recharge and saline water conversion is very important, and will produce basic information of great value to the water works industry. Research in reservoir evaporation control, and watershed and groundwater storage management, based on fundamental investigations in the hydrology, hydraulics, and related scientific field is also very important. Equally so are research studies needed in the field of water legislation at Federal, State and local levels. All of this points to the need for more recognition of the problems of water resources by those in charge of water utilities.

Simple arithmetical solution of the values of water for various purposes ignores, social, historical, legal, and traditional backgrounds of our democracy. Many of us will have to learn the "facts of life" with respect to water resource legislation. In many instances, domestic water supplies have been held as the highest use, with all other uses subsidiary to it, while in other instances, human (individual) use is declared preferential. The difference between "domestic" and "human" is precise and of terrific importance in at least one state where probably only a handful of engineers and lawyers are conscious that such a distinction exists.

We are no longer, in many places, immune to legal attack on wasteful practices in water use where there are competitive demands for the available water. The confusion between "domestic" and "human" use is understandable, but they are not synonymous.

So, while 1956 has seen much discussion and some action, particularly in the legislation of water boards, and many resource studies, it should be quite apparent even to the casual water superintendent that 1957 will see more talk and also more action in the complex legal problems of water resources.

Hydrology

The need for more stream flow records, suggested so many times in the past and again several times this year, cannot be overemphasized. Suggestions have been made that the stream gaging program be devoted to the operation of secondary stations, satellite to a firm network of long term base stations. The excellent stream gaging and record gathering program of the U.S.G.S. and some states should be vigorously supported by the water works industry. If one tenth the interest shown by the industry in metering of water to the consumer were devoted to aiding in the measurement of our water sources, hydrological calculations would rest on more firm foundations. Excellent papers have been presented on the use of various design and operating curves based on these records and on statistical method for the storage regulation and economics of reservoirs.

Of particular interest to larger cities was a panel discussion held at St. Louis on controlled draft from reservoirs and the use curves drawn from past records in the controlling of reservoir drawdown during drought.

Welcome additions to the understanding of evaporation, transpiration, soil percolation, and underground flow have been made by several contributors.

The AWWA Committee on Artificial Ground Water Recharge reports that this practice is becoming more prevalent, but is done only on a regional scale in a few areas. More recharge operations are expected in the future. It is still an art, and each situation requires individual study. Ground water lysimeters are well suited to the investigation of many aspects of water spreading and can be used in predicting full scale field spreading. Studies on ground water tracing by chemicals and radioactive materials indicate there is no single tracer good for all conditions. Iodine 131 as iodide and natural tritium show promise. Sodium fluorescein, sodium and calcium chloride are also good. Characteristics of the soil are important in the type of tracer used.

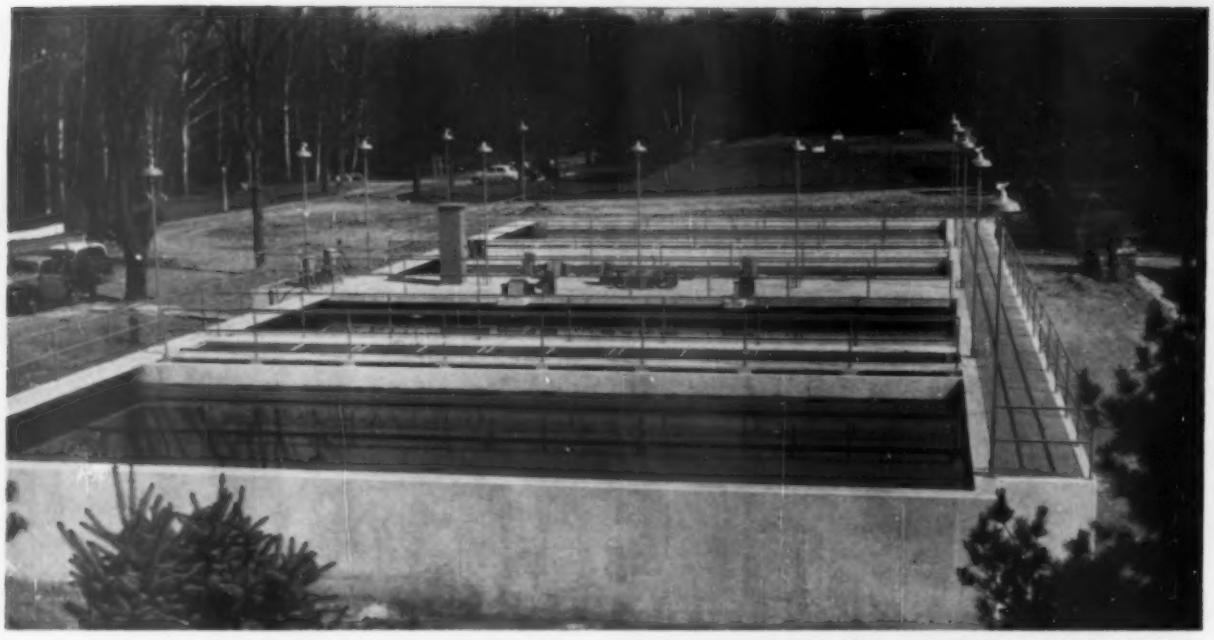


Photo courtesy of Walker Process Equipment Co.

LANCASTER, Pa's, Columbia Station Plant (8mgd.) adds clarification basins equipped for continuous sludge removal

A monograph for the rapid analysis of aquifer tests has been developed for the solution of Theis non-equilibrium equations. The method is subject to some errors, but the time required for solution is very short.

Overpumping of ground water continues and in some coastal areas has necessitated seeking of more distant sources of supplies. Several of these cities have developed auxiliary ground water supplies to take care of peak demands and prevent salt water intrusion into the main ground water supply.

Suter describes an excellent example of ground water recharge near Peoria, Illinois, where overpumping had created a serious depletion. Chlorinated river water is conducted by gravity from the Illinois River into a relatively small gravel pit. Considerable fundamental operational data has been collected during the four years of operation of this recharge study.

Legislation, Legalities, and Controls

Reference has already been made to the passage of many State laws with reference to water resources and development. Of direct importance to the industry are three pieces of Federal legislation, Public Laws 627, 911, and 1018.

The Federal Aid Highway Act, 1956, Public Law No. 627, was passed after considerable discussion and argument. The water works industry presented its views through AWWA and others. This act allows reimbursement of utilities, including water, for the expense of relocation of mains, conduits, etc. caused by the Federal Highway program, provided such a repayment does not conflict with present state laws. Many states have different practices and different methods within the individual states. To protect themselves and be able to qualify, the water works utilities in the several states will need to pay attention to the state legislative actions during the early months of 1957.

The Health Amendment Act, Public Law No. 911, supported in general by the water works industry, strengthens its provision with regard to research grants, state program grants, and Federal enforcement of pollution abatement on interstate streams. Of particular value to the water industry will be research and educational grants.

Public Law No. 1018, of August 7, 1956, broadens the Department of Agriculture's assistance to the State, Counties, and Cities in developing watershed protection, flood prevention, and water conservation projects. Such projects must be initiated by the locality. There are several restrictive, as well as enabling measures, included in the statute.

The three samples of Federal legislation in 1956, quoted above indicate only a small portion of congressional activity in the field of water development. Water utilities both individually and collectively will need to inform themselves continually of Federal and State water legislation.

An interesting development in 1955-56 in the state of California has been the development of regulation for *all* water utilities by the public utility commission. The California Section of AWWA was asked to participate and has been active in sitting in conference with the staff of the Commission. As last reported, there were differences in the "Service Standards and Rules" on such items as wastage, pressure, service installations, procedures, and inspection of customers' plumbing. This type of regulatory development makes sense.

Murdoch and Tobey both have discussed the nature of the police power of the individual states and the rights of citizens under the first and fourteenth amendments. Between 1953 and 1955, the Supreme Court of the United States and the Courts of last resort in six states have ruled that fluoridation of a water supply is a valid and reasonable exercise of the police power of the State in the interest of public health, and that it does not violate any of the rights of individuals vested in them by the Federal and State Constitutions.

Education

The graduate traineeship program of the Federal Government should aid the water works industry by developing men for the general field of public health. A further example of educational activity is shown by the Newark, N. J. Water Department where thirty high school boys, chosen

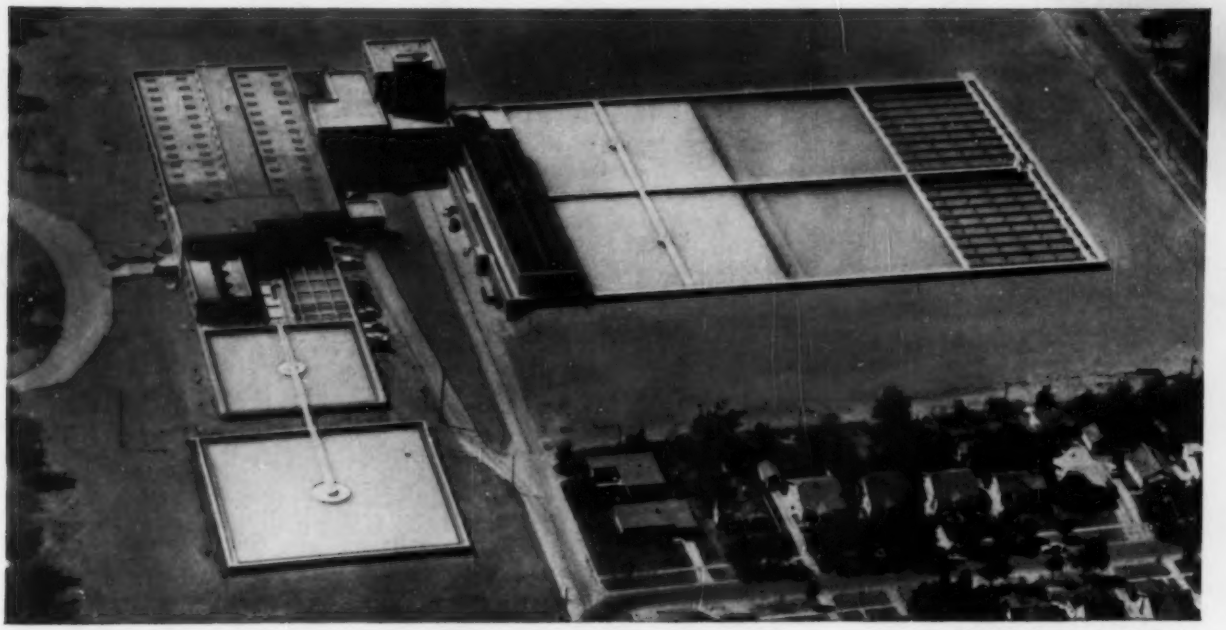


Photo courtesy of Dorr-Oliver Inc.

WICHITA, Kan., completes its third plant addition in 15 years, to bring capacity to 112 mgd. from original 20 mgd. in 1940

by the department, spent the 1956 summer on a program of watershed maintenance. This very successful venture will be repeated in 1957. There are, of course, numerous examples of this type of educational operation on an individual level, but it is doubtful if such a whole hearted attack, has been made either on a watershed or on high school education.

Numerous excellent in-service training programs have been or are being developed for water works personnel. More of this type of educational operation is needed throughout our industry. So much is left to chance in non-organized training that even for the relatively small utilities there is everything to gain by setting up semi-formal training for utility personnel.

Short courses by Universities and Colleges, Sections of AWWA, and State Boards of Health have been continued throughout the year. These courses appear to be enthusiastically received.

The magazines devoted to the water works industry have developed a series of splendid articles for operators and engineers alike. Symons and Gilcreas are to be complimented for an excellent series of educational texts in their respective magazines.

Several scores of engineers, superintendents, and others are contributing their time and effort to the development of manuals for water superintendents and operators under the guidance of Education Committee of AWWA. Several thousand dollars have been set aside for this work. In 1957, some of the volumes will be published.

The American Sanitary Engineer Intersociety Board, (composed of members appointed by ASCE, AWWA, APHA, Federation of Sewage Works Association, and ASEE) is now receiving applications for certificates of special knowledge in sanitary engineering. Certified persons will be carried on a roster to be known at the American Academy of Sanitary Engineering.

Water Purification

Continuous development in the field of water purification and treatment was ably demonstrated in an excellent talk by Wolman in his historical discourse on "75 Years of Improvement in Water Supply Quality" before the 75th Annual Conference of AWWA in St. Louis.

The year 1956 was in no way different from the years of the preceding century. Theoretical and practical aspects of water quality still stir men to find out why, to try, and to evaluate. The old and familiar iron and manganese problems are still the subject of examination and test, and there is still must research. Copper sulfate has been used to remove manganese deposits in a clear well. Recent studies on the effect of iron on high capacity zeolite softeners have indicated that treatment of the zeolite with sodium hydrosulfite or 10 per cent hydrochloric acid to remove the iron may return the zeolite to its original capacity. Proper dosages of polyphosates in the water prevent iron retention. It is better, however, to remove the iron prior to zeolite softening.

One interesting article advocates the use of a small-scale inexpensive pilot plant to determine by controlled experiment the better method for removal of iron and manganese which so often appear in ground water supplies.

The Technical Advisory Sub-Committee on Research of the Association of the American Soap and Glycerin Producers and the Taft Engineering Center in Cincinnati have reported on methods of identification of anionic synthetic detergents. The detergent with some interfering substances is removed by activated carbon, extracted from the carbon by alcohol and further treated with a reacting organic ammonia. By infrared spectroscopy, demonstrated by others, identification of the detergents in the solutions can be made. Tests were made on four types of anionic surfactants.

Studies on the effects of synthetic detergents on coagulation indicate wide variation. The surface active agents in greatest use have no adverse effect up to 10 ppm concentration but interference in alum coagulation of water is caused primarily by the complex phosphate builder compounds in the detergents. Removal of detergents from water is reported from Chicago as a difficult problem. Various materials such as alum, chlorine dioxide, sodium silicate, bentonite, activated

Photo courtesy of C. I. Pipe Research Assn.

PHILADELPHIA, like numerous other cities, has an honest-to-goodness program of water main improvements under way

carbon, and others were tried with varying results.

An interesting, recent experiment in the field corrosion was to determine the effects of pH and water velocity on steel and iron water pipes. With due caution, the investigator warns of extrapolation of these short term tests. Indications are there is little change in long term corrosion rates of iron between pH 5.5 and 9.0 at a particular velocity. Decrease or increase beyond these limits increases the corrosion rate markedly. Some serious pitting occurred at pH 6.4. The corrosion rate is a function of the velocity raised to some power as long as a laminar sublayer exists.

Standardization in use of magnesium anodes has been adopted in Los Angeles as the most economical method of protecting steel tanks in conjunction with coal tar enamel painting. Designs and installation methods have developed.

Great strides have been made in demineralizing water for boiler feedwater and industry. Since 1937, the ratio of multiple to mixed bed type of installations is three to one. Each system has its advantages and disadvantages. Some problems of resins defects, instrumentation and control still exist.

Hydrazine, for dissolved oxygen removal from boiler feedwater, is being used successfully in several high pressure steam power plants (1350 to 2500 psi). Seventy-six pounds of hydrazine replaced 3600 pounds of sodium sulfite in treating 46 million pounds of feedwater daily. Labor cost was also reduced.

Reduction in corrosion by careful operation of small water and steam boilers can be obtained, by releasing dissolved gases through boiling of the water and by adding sodium sulfite occasionally as make up water is added.

Baylis reporting from seven years' filtration of low turbidity Great Lakes water says that 5 gpm per square foot filtration rate produced excellent water. Turbidity of the 4 to 5 gpm filter effluent is not measurably greater than from the 2 gpm rate. The filter run is inversely proportional to the filter rate. He suggests that cotton plug filters, for measurement of coagulant in effluents, should be installed on all rapid sand filters, especially those operated at the higher rates.

Hudson, in an excellent treatise on filtration rates, concludes "The indiscriminate adoption of filtration rates above 2 gpm per square foot should not be encouraged but they may be adopted if there has been sufficient experience to establish limiting values of the filterability index.

An excellent review of the theory of sedimentation and some economic studies on mechanical sludge removal have been presented. It is quite evident that inlet baffling and outlet control, and the effects of wind, are still items to contend with in sedimentation basin design and operation.

Distribution

An interesting approach to the problem of population growth forecasting has been recently published. This paper, based on Stewart's population theory, is a welcome addition to the sparse knowledge in an important field. The work has been applied to cities such as Manchester, Budapest, Melbourne, and Los Angeles.

Water consumption studies have been and are being continued in some cities in the country. Some excellent work has been done in Baltimore. These data, some already published and some still being collected and analyzed, will prove beneficial in future distribution system designs. One author has pointed that it is necessary for the industry to pay more attention to the service lines from the mains

Photo courtesy of Price Brothers Co.

CINCINNATI makes important trunk main extensions, employing 30 and 36 in. prestressed concrete pipe

into the customer's home. Failure of service piping to deliver the required water at a reasonable pressure reduces the effectiveness of a well-designed and operated system and makes no friends for the water utility. Residential development in hilly areas in many cities is causing severe hydraulic problems in pumping station, surge control, pressure, storage, and distribution main design. The use of pressure and flow meters and recorders, both stationary and movable, by numerous cities and analysis of the data obtained, in aiding in development of better storage, booster station and main design. Many small cities are seriously concerned with these matters.

Difficult anaytical and procedural developmental patterns will appear with the impact of the new highway program. The effect of the program, will create new problems for the manager, utility designer, and the operator. Residential pumping stations, centrally controlled, and completely automatic, are now realities. Their external appearance and internal noise suppression require good choice of pumps and equipment and good architectural design to develop better public relations.

Due to the interest in control systems and the development of valves and controllers for other industries, numerous articles on valves of several kinds have recently appeared. Similarly new methods of measuring flow and pressure, (particularly electrically and magnetically) have been developed or modified. These activities of generic research on information transfer and control and re-examination of old theories, designs, and practices, are stimulating and speak well for the determination of our industry to develop better control and operational devices.

One would imagine that research in pipe materials, pipe coatings, and linings, pipe joints and jointing materials, main disinfection and pipe laying would by now have been slowed down. The reverse seems true in 1956.

The field of pipe and equipment manufacture, joints, laying practices, locations and new construction was as active in 1956 as ever. Numerous reports have been made of the large pipe line and filtration plant expansion, constructed or projected in 1956, not only in the North American countries, but also in South American and South Africa.

New Plants

Many filtration plants have been constructed recently, and reported in 1956, and numerous utilities, large and small, are designing such plants or have plants under design for construction in the near future. The newest Miami 40 mgd softening and filtration plant is now in operation. The filters are operated at 3 gpm per square foot. Diesel pumping units are used in the plant and in the well field supply. With these engines all the electrical supply for plant operation can be developed at the plant during emergency operations.

The St. Louis County Water Company completed in one year, from design to operation, the North County 36 mgd filtration plant. Presedimentation, primary and secondary flocculation and sedimentation are followed by 3 gpm per square foot of filtration. One of the six filters is provided with experimental suspended solids contact stabilization.

Extreme urgency of water shortage, caused by uranium, coal, oil, gas, and helium discoveries, influenced the City of Farmington, New Mexico, to construct a 4 mgd filter plant in three months. This plant was built of sheet steel and concrete. As in so many of the plants this year, every advantage

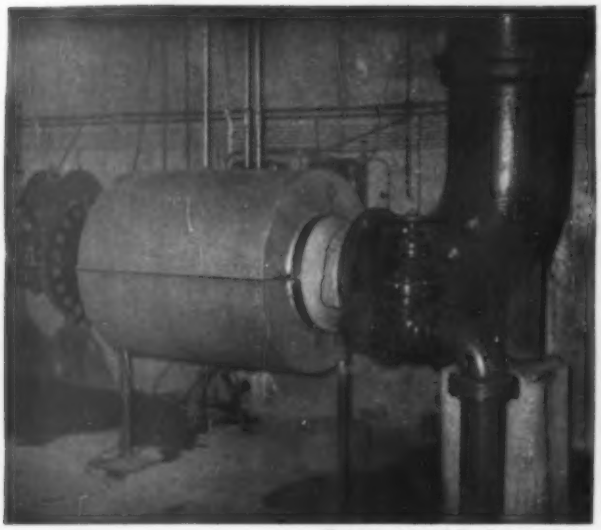


Photo courtesy of The Foxboro Co.

MAGNETIC flow-meters are very new: this one is being tried in Chicago's South District Plant

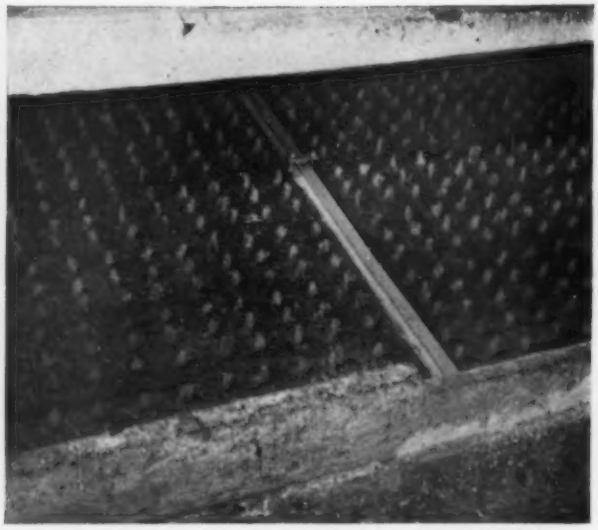


Photo courtesy of M-C-G Co.

FILTER BOTTOM of new non-corrosive "Criscrete" construction being tested for uniformity of wash distribution

was taken of automatic recorders and controls.

The designers of the Lynchburg, Va., plant, to conserve one hundred feet of head from the mountain reservoir, resorted to vertical design of its new filtration plant, making use of a large vertical coagulation tank, with mechanical flocculation tanks suspended in the top of this tank and filter units on the sixth floor. The Water Department offices, laboratory, meter shop etc. are housed on the lower floors. Special attention was paid in this design to the architectural features, since the plant is located in a residential area. No statement was made in the article for renting the roof for a penthouse or night club, but there is the possibility of leasing the roof for radio and television broadcasting.

Indianapolis converted the slow sand filter part of the White River Treatment Plant into a rapid sand filtration plant. The filter basins were converted into mixing and sedimentation basins. The roof over the old filters was retained, with the expectation of achieving better sedimentation, algae control and chlorination. The filter piping and control are designed for an overload rate of 3 gpm per square foot. The beds are, however, designed for the nominal 2 gpm per square foot. Stationary orifice type surface wash is being used. A master control rate-setter spreads the load evenly over the six filters. Rate-of-flow and head loss is transmitted pneumatically

Instrumentation and Automation

In recent years many improvements and developments of new control systems for water plants have been achieved. A good start has been made in the water filtration plants, particularly in the last three years. The record of the design of automatic control systems for domestic water filtration plants during 1956 was excellent. As in many new developments, there are problems still unresolved. The question of automatic control must be weighed in each individual design. The water superintendent or operator is still responsible for furnishing a potable water—a burden which does not rest lightly on any man.

One of the outstanding instances of automatic control of a filtration plant is at the Broadside plant in Scotland. All operations at this plant are conducted from a main panel center by means of a sequencer using standard telephone relays. This sequencer controls the filter washes in the order of indicated lost head, provided twenty minute delay before starting the next filter if needed; provides means of varying duration of filter bed air scour, for electricity failures, manual selection, alteration in sequence of washing filters already in queue, warnings, and assurance that each operation is complete before the other starts. In addition, the output for each filter is governed by its 12-inch module automatic flow controller which can be set to any desired output and maintains this output irrespective of the variations in the filtering head loss.

By means of conductivity difference, automatic control of chemical coagulation may be possible. Basis for this research is the reaction of alkalinity of the water with the weak acid alum. Conductivity is used to measure the end point. By using conductivity *difference,* the changes in conductivity of the raw water, the effect of dissolved gases and dissolved solids is said to be eliminated.

Comparative tests on the relative efficiencies of diatomite filtration and conventional sand filtration were made on the same raw water for several years. Comparisons of the cost of construction and operation have been presented, and these studies are being continued.

Experimental results of chlorinating deep anaerobic stratified waters in Los Angeles reserviors are encouraging as a palliative warm season treatment for taste and odor control.

Fluoridation

The fluoridation of water supplies throughout the country has been subjected to considerable voting and vocal criticism in the country, during the year. No tallies of the population served are available at this writing. Several articles have appeared, however, on the techniques of applying fluorides to water and safety practices in the handling of such materials. Several large cities and numerous smaller ones, are using hydrofluosilic acid. In the field of steam generation, the effect of flourides in 800 psi steam boilers up to concentration of 62 ppm is not appreciable. At 1400 psi pressure, specific conductance increases with pH value and decreases with an increase of fluorides.

Removal of crenothrix bacteria from mains and procedures in disinfection of mains with chlorine are additions to a long list of practices which have developed the art of main

Photo courtesy of Minneapolis-Honeywell Co.

AUTOMATIC chemical dosage control at Macon, Ga., is being attained through instrumentation and automation with resultant chemical savings

Photo courtesy Builders-Providence Inc.

CONTROL panel and instrument board for filter control in the speedily built North County Filtration Plant of the St. Louis County Water Co.

disinfection to such a satisfactory level.

Laboratory Procedures

There are many excellent suggestions in numerous papers on taste, odor, and algae control. The use and care in handling the numerous algicides, published tests of algicides, development of aquatic laboratories and procedures, colored charts of algae, special microscope slides for algae counts and algae surveys, have been added to this expanding and interesting field of endeavor.

Derby and Taras recently appealed to users of Standards Methods, 10th Edition, for their evaluation and criticism of the new and old methods in laboratory practice. They and other members of the committee urge all scientists and laboratory personnel to write of their experiences with the test proceedures.

Such experiences have already found their way into print in the form of articles and editorials, particularly those advocating the use of the membrane filter for bacteriological examination of waters. Advantages and disadvantages of the method have been evaluated. Several studies, some on developing statistical data on comparative methods and others on modifications of the proposed methods and materials have been added in 1956. Field kits for the use of membrane filters for examination of the bacteriological, chemical, and physical qualities of water are now available.

Large reductions in time of incubation for Esch coli may be achieved in the future if preliminary results are confirmed. This method is based on passing the carbon dioxide, produced by Esch coli in lactose broth labeled with C^{14}, through a paper fiber pad moistened with a saturated solution of barium hydroxide. The radioactivity is then measured in a gas flow Geiger counter. This suggests an excellent approach to resolve a time consuming task.

Chlorine residuals can be accurately determined by amperometric titration and continuous residual chlorine recorders have been developed after long experience.

A joint committee on "Uniformity of Methods of Water Examination", composed of representatives of APHA, ASTM, ASME, FSWA, U.S. PHA, AWWA, and the U.S. Geological Survey was formed in 1956 to secure uniformity of content and terminology of methods of examination by various groups.

Desalting and Removing Radio Activity

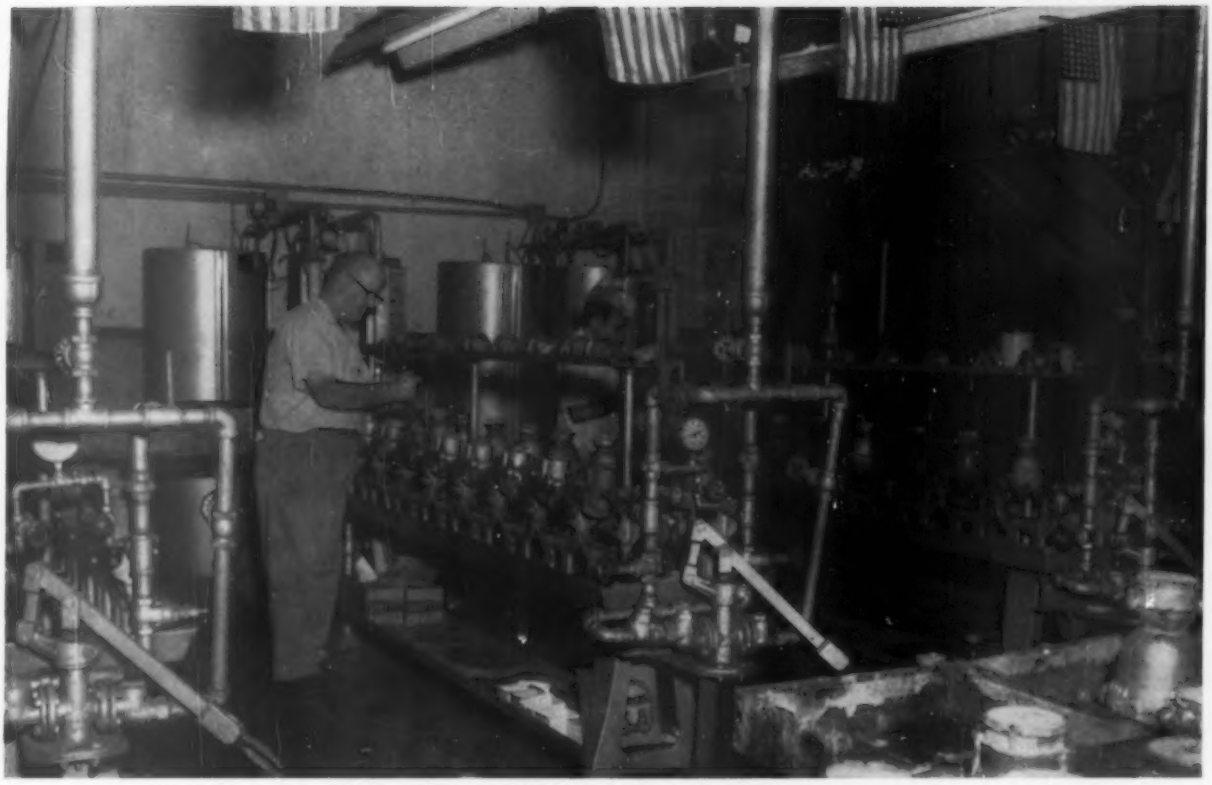
Cost analysis of various methods of development of usable water from low saline waters indicates that the electrodialytic process for demineralization is the most economical at present. These costs do not compare with the lower production costs of the conventional water treatment processes of the waterworks industry. Much research is needed before these high costs are reduced significantly. Compressive distillation of sea water on ocean vessels has been vastly improved since the war by development of an expansible labyrinth to reduce steam losses from the compressor.

Effective removal of radioactive isotopes from water by conventional coagulation, sedimentation, and filtration does not look too promising at present. Certain radioactive isotopes of relatively long half life can produce serious health problems. Removal of some of these to a point where they are below the maximum permissible concentration presents real problems. Considerable work on laboratory scale has and is being performed, and the water works industry, fortunately, is to be represented by AWWA at the next nuclear congress to be held by the Engineer's Joint Council in Philadelphia, Mar. 6-11.

Research in the water supply field of a basic nature is being promoted or undertaken by the U.S. Public Health Service; universities, private laboratories, and the AWWA. Momentum has been gained in 1956 which will extend our knowledge in many phases of water treatment, control, quality examination, hydraulics and hydrology. Some of these studies are already under way.

With Appreciation

The writer wishes to thank the many fine men who, at section conferences have added so much to the picture of water supply in 1956. Not to have mentioned all worthy papers and their authors is unforgiveable, but the writer craves indulgence at this time and begs as the reason the limits placed on this review and heavy schedule of activities both in the office he is privileged to hold in AWWA and educational and State water resources activities.



METER test operations, Philadelphia Meter Shop

Philadelphia's Incentive Pay Plan Boosts Meter Shop Output

Philadelphia first to adopt incentive pay plan as feature of meter-shop reorganization on a production line basis.

by G. E. ARNOLD

Mr. Arnold is General Superintendent of Water Works at Philadelphia, Pa.

He has a right to be proud of the accomplishments of the Philadelphia Water Dept. since he became its operating head and Samuel S. Baxter became Commissioner of Water.

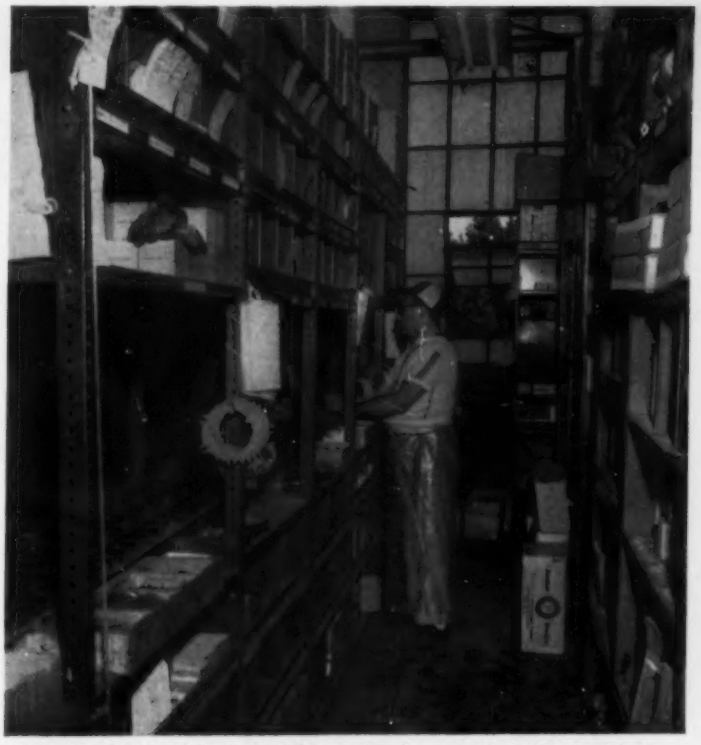
PRIOR to 1918, there were few water meters in Philadelphia. At that time it was decided that metering should be initiated, and an ordinance of the City Council in that year required that all new construction built in Philadelphia after that date be equipped with a meter on the water service line. Later, another ordinance required that all commercial and industrial establishments be metered regardless of age. By 1952 there were more than 500,000 active water services in Philadelphia of which about 320,000 were metered and 180,000 were unmetered. All of the unmetered services were in residences older than 1918 and were scattered throughout the city.

During 1952 the decision was made to complete the metering of the entire city which meant the installation of water meters on the 180,000 water service lines then unmetered.

At the time the decision was made to complete the metering of the city,

METER CHECK-OFF LIST	WATER DEPARTMENT METER DIVISION
METER	DATE
	S. B. BEARING
	BOLTS AND NUTS
	BOTTOM
	REGISTER BOX ONLY
	REGISTER BOX COMPLETE
	TOP CASE
	CHAMBER
	SPLIT COLLAR
	REGISTER BOX COVER
	REGISTER CUP
	DIAPHRAGM
	DISC
	REGISTER FACE
	GASKET
	REGISTER CUP GASKET
	COMP. GLAND
	REGISTER GLASS
	CHAMBER INSERT
	CLAMP NUT
	S. B. NUT
	S. B. BEARING NUT
	S. B. CLAMP NUT
	REGISTER BOX PIN
	REGISTER
	SPLIT CONTROL RING
	THRUST ROLLER
	SCREEN
	SCREWS (REG. CAP)
	SCREWS (CHAMBER)
	SCREWS (CHAMBER HOLDING)
	SCREWS (REG. CUP)
	SCREWS (DIAPHRAGM)
	SCREWS (HEX TRAIN)
	SCREWS (TRAIN)
	DISC SPINDLE
	S. B. SPINDLE
	TRAIN
	WASHER
	S. B. BEARING WASHER
	REGISTER SPRING

METER check-off list used by the meter inspectors for ordering replacement parts



STOCK ROOM, with clerk filling meter inspector's order by placing replacement parts in meter pan

it was decided that all water meters would thereafter be installed or removed only by Water Department employees. Prior to this time meters had been installed by plumbers with the Water Department employees engaged only in removal or reinstallation when meters required repairs. This decision was not popular in some areas and resulted in a law suit.

The suit was filed against the City officials, particularly the Water Commissioner, contending that the City and the Water Department were depriving plumbers of business enterprise by insisting that consumers buy meters only from the City, and that the Water Department make the installations, contending that the requirements of the Water Department regulation on universal metering were discriminatory and that the City was violating the Constitution of the United States and that of the Commonwealth of Pennsylvania.

The trial occupied several days of testimony and became quite involved. The Lower Court handed down its decision on June 17, 1954 reciting thirty findings of fact, all thirty of which were favorable to the position of the City and the Water Commissioner, as defendants in the case.

The decision of the Lower Court was appealed to the State Supreme Court and was heard by the high court in January, 1955. The State Supreme Court handed down a decision upholding in full the findings of the Lower Court and Universal Metering was resumed. Our schedule calls for completion of the metering of the entire City by June 1, 1957.

This case for reference purposes is listed as 2D&C2d761. It was affirmed in 382, Pennsylvania 399.

The Meter Repair Program

An entirely new concept of water meter repair was instituted about three years ago in Philadelphia and has resulted in a vast increase in the number of meters repaired, without increase of the number of personnel required and at a considerable reduction in overall cost.

In 1952 there was a large back-log of unrepaired meters still in service on consumers' premises in Philadelphia. These meters totaling about 30,000, were supplemented by an additional 5,000 meters in the Meter Repair Shop awaiting repairs. These meters were being repaired at the rate of about 400 a week. The customary procedure, then, was for each repairman in the shop to service a meter in its entirety by himself; including dismantling, cleaning, and repairing.

In 1952 a firm of industrial consultants was employed to review the operation of the Meter Shop and to recommend improvements. As a result of their survey, the Meter Shop was re-organized, new equipment purchased, a new procedure established and the employees placed on an Incentive Pay Plan. This is believed to be a complete innovation in compensation of municipal employees, but it has proved well its worth in Philadelphia.

Replacement of Meter Parts

Now, as the meters come into the Repair Shop, the necessary records are taken and then the meter moves to a break-down bench where the main case bolts are removed with a power wrench known as an impact wrench. Following this, the meter is disassembled and all of the parts placed in a square steel pan about 2" deep and 15" square. Portions of the meter are then given an acid dip to remove scale and grease, after which the clean parts are rinsed and then the meter and parts go to an inspection bench. Here the inspector carefully examines each part of the meter to determine whether it can be reused or must be discarded. As he discards a meter part he makes a mark on the checkoff sheet, reproduced herein, and the remaining parts of the meter, with the checkoff sheet, are put in the steel pan and rolled on

CONVEYOR carrying repaired meters from assembly benches to the test benches.

a conveyor into the stockroom. Naturally, this operation is a very important part of the repair and replacement system. The inspector must be thoroughly experienced and know his business, if new meter parts are not to be wasted or a meter reassembled only to fall short on the test bench and have to be returned for dismantling and re-assembly.

The stockroom clerk uses the checkoff list to place in the pan, a part for each one properly marked on the list. The complete meter with the old and new parts then travels to a window where the men on the repair bench take over the meters for assembly. The stockroom clerk keeps the checkoff lists and totals them at the end of the day for his inventory records.

REPAIRMAN at an assembly bench.
Note roller conveyor in background with meter in pan.

The Repair and Assembly Bench

The man at the assembly bench put the meters together, gives them a quick water and air test to see that they are operating properly, and then places them again in the steel pans following which they travel on a conveyor to the test bench. All meters are given a thorough test and any meter not meeting the test is returned for correction to the man who assembled it. After test, the meters are rolled on another conveyor to the paint spray booth, where they are given a coat of paint and then placed on racks to be installed in consumers' premises.

In summary, the meters move through the shop on a production line basis. No one has to carry a water meter more than five or ten feet in the shop. They move from one process or location to another by gravity roller conveyors, each meter being kept to itself in its steel pan. Each step in the operation is performed by one man who is especially trained and qualified for that step. We are currently repairing about 1,400 meters a week in the shop with the same number of employees that formerly repaired 400 a week, and the repair work is being satisfactorily done.

OLD METERS are dis-assembled with impact wrench for removing case bolts.

SPRAY PAINTING of repaired and tested meters which move into storage.

The Incentive Pay Plan

One of the most important developments in connection with the increased production in the meter shop is the incentive pay plan on which most employees work. Time studies were carefully made of each operation and a standard established for that operation. The standard minute is a 60 second minute and each operation receives a credit in seconds and fractions to make up the total amount of work that a man should be able to do in 60 seconds. If he exceeds this basic standard, he receives additional pay for the extra work done, in accordance with the established standards. If a man fails to meet the standard, he receives the standard pay regardless of his deficiency; but if a man consistantly falls below the standard, he is given another assignment or let go. It was this guarantee of the basic wage which brought about approval of the plan by the union.

In determining the standards, consideration was given to the difficulty of the work on different makes of meters—some meters receiving a larger basic standard for certain steps than other makes of meters. Records are kept of each man's operations each day, and the total number of minutes of effective work he has produced during the day are considered in making up his daily wage. Field operations of removing and installing meters, or making minor repairs on the consumers' premises, are also on an incentive pay basis. Credit is given for each operation performed by a field man. For example, he receives a certain credit for a "no-response" when there is no one home. He receives certain credit for removing an old meter and installing a new one, and he receives certain credits for minor repairs such as re-packing a stuffing box. Reasonable driving time is allowed in moving from one job to another. Each installation crew is given a larger volume of work than they can accomplish in one day so that there is assurance that they have plenty of work to keep them busy during the day. Shop and field inspections are made on a spot-check basis to see that the work is properly done.

The basic pay standards were ap-

LARGE METER under test in shop. Incentive pay does not apply in large meter repair and testing for reasons given in text.

proved by the Civil Service Commission and have been revised once since they were originally instituted. In some cases, the basic standards were increased and others decreased as a result of operating experience under the new plan. So far as is known, this is the only incentive pay plan in operation in a municipal water system, and it is working satisfactorily. On an average the men earn an incentive bonus, amounting to 20% of their base pay, and the volume of work being done has greatly increased with an over-all reduction in labor costs. To repeat, the work is satisfactory.

Large meters are not handled under the incentive pay plan because of the wide variation between makes and types and the repair work which must be done. Both field and shop employees in handling large meters are in a higher classification schedule and receive higher standard pay. The institution of an incentive pay plan for handling large meters does not appear to be practical.

What it Has Accomplished

All together, the revised schedule and new method of operation has tripled the number of meter repairs made per month in the shop, and has also resulted in a vast improvement in field operations. Within two years after the incentive pay plan was instituted and the new procedure in the shop started, the backlog of meter complaints was wiped out, and today the Meter Shop is pracically current with service work.

Prior to 1953 meters had never been brought into the shop except on complaint, indicating that they had either stopped or were leaking or in bad order. As a result, there are many thousands of meters in the system which have never been inspected or repaired. In 1954, a rotation schedule was established under which all meters will be brought into the shop for repair at least once in ten years. It is felt that this rotation schedule will result in better metering of the water and a definite increase in revenue. Many of the old meters brought in are found to be non-registering at the low flows. Because the meters had been neglected, the cost of repairs is higher than it would be for meters kept in good condition. The labor is very little more in cost, but the parts are running considerably above the average, due to the bad conditions of the meters. We are currently finding that the labor costs for repairing a 5/8 inch meter are $1.75. Before the new plan was instituted, the labor cost for these repairs was $3.50 on the average.

Philadelphia is now completing the metering of the entire city and will very shortly have over 500,000 active metered accounts. The Universal Metering program has been previously described in other articles. The development of the Universal Metering program, together with the re-organization of the Meter Shop and the schedule of rotating meters, has resulted in definite improvement in the over-all metering practice in Philadelphia. Substantial increases in revenue are resulting from the new metering program, and meters are currently being kept in good repair.

Anyone interested in our meter shop reorganization, or Incentive Pay Plan in the metering program, is invited to come to Philadelphia to inspect our operations and obtain more details than could be given in an article of this length.

Adkins Joins John Hawkins as Ass't. Sup't. of Water at Greenville, S. C.

William W. Adkins, until recently Director of Utilities at Burlington, N. C., has been appointed Assistant Sup't. of Water at Greenville, S. C., according to recent announcement by John L. Hawkins, Sup't. of the Greenville Water Dep't.

Mr. Adkins, a native North Carolinian, is a graduate of N. C. State College. He was Asst. Supt. of Utilities at Ashboro, N. C. before moving to Burlington as Supt. of Utilities.

As an active member of the N. C. Section of the Div. Water Works Ass'n., he served as chairman of the Section in 1951, the same year that he was elected president of Asheboro's Kiwanis Club. This year Mr. Adkins was further recognized for his acumen as a water works manager by being cited for the Geo. W. Fuller Memorial Award which he will receive at the 1957 Convention of the Am. Water Works Assn. at Atlantic City, May 12-17, 1957.

Meter Maintenance Program Materially Increases Revenue at Hollywood, Fla.

According to Bennett R. Bolen, Director of Finance, Hollywood, Fla. an organized program of meter maintenance has resulted in increasing the city's revenue from water distribution by nearly $75,000 in one year, while also reducing water waste.

An increase in unaccounted-for water led to a survey in December, 1953, which showed nearly half the meters out of order. A heavy percentage of the trouble was traceable to sand infiltration which followed extensive contract work on water lines.

A water department employee was selected to attend a manufacturer's meter school in Atlanta for training in repair methods. As the repaired meters became available, they were substituted for other meters, many of which were found to be recording less water than was flowing through them.

From: *"The Florida Municipal Record."*

Concentric Orifice Diameters

(Formula Corrections)

The artilce on "Concentric Orifice Diameters," and their determination for fluid flow measurement, by Alexander Goldstein in our November 1956 issue contained some typographical errors which the author has called to our attention. Will the readers having an interest in Mr. Goldstein's article note the following corrections in their copy.

1. P. 515, col. 3, line 11, formula (2c). The h/ρ under the radical sign should be $h\rho$, the division line/ deleted from only this formula of the three in the group.
2. P. 515, col. 3, line 17, formula (3c). The h/ρ under the radical sign should be $h\rho$, the division line/deleted from only this formula of the three in the group.
3. P. 518, col. 1, line 5, the B should be the Greek letter β.
4. P. 520, col. 1, line 8, the $-1/4$ should be up about 1/8 inch to represent a power exponent.
5. P. 521, col. 2, line 8, $x0.605^2$ should be inserted after 0.997^2.—ie, $0.997^2 \times 0.605^2 \times 140/1.494$

Satisfaction

He is a man of sense who rejoices in what he has, and does not grieve for that which he has not.—*Epictetus*

Sometimes the Customer is Right!

An open letter from one superintendent to another

Dear Bill:

The other night at our district association meeting I told you I would look through my file of letters from unhappy customers for a couple of illustrations of what happens when careful consideration is given to the reason a customer had for making a complaint. We both agreed that he squawked because something happened to him that he didn't like and that it's up to us to find out whether he was justified in doing so, or not. There is a good possibility that he had some justification, as I think both of us have found out.

As you know, there are times when a meter reads the same as it did the month before. In such instances our billing policy was, and still is, for that matter, to base estimated usage on the average of the previous three months consumption and bill for that as the fairest procedure.

Our mistake, if that's what you call it, was to give the customer a bill having the same overall appearance as one, on which the meter shows registered use. We added the estimated consumption to the previous month's meter reading and put the assumed present reading we got into the billing machine. In fairness to us, I will say we used a symbol next to the dollar amount that indicated the bill was an estimated one.

One of our customers must have been allergic to estimated water bills, though, for the day he got one he dashed off a blue ribbon winner of a letter, telling us that from now on he wouldn't put any faith at all in the accuracy of our billing and refused to believe we read his meter, or anyone else's, for that matter, because why did he have a meter reading on his bill that didn't begin to check with what he could see with his own eyes on the meter register. Such goings on confirmed his definite knowledge that our meter readers read everybody's meter from a bar chair in the neighborhood beer joint—etc., and so on. To top it off, he had proof, if he wanted it, that he had been out of town for longer than the period covered by the bill and, to be safe, had turned off our curb stop before he left.

We were in a bad position, of course. Explanations were of little effect because this customer was convinced we wanted to get to his pocketbook. Right then and there it was decided to change our "estimated bill" procedure.

We Change Our System

Thanks to him, and I made it a point to call him up and tell him about it, we now show no figures on an estimated bill other than the dollar amount with the appropriate symbol. In addition, we stencil a notation on it with our addressing machine that says "This is an estimated bill. Your meter did not operate this month. A service man will call to investigate the reason."

Thus, if the meter mechanism is at fault, no fictitous "present reading" can haunt us. If the meter did not operate only because the customer used no water, we have a reasonable and acceptable explanation and an adjustment slip will reduce his bill to the monthly minimum.

This procedure tells the customer we had noticed his meter did not register. Along with it he gets a sample of our operating efficiency, because we always try to be out there checking the meter on the same day his estimated bill arrives.

In connection with meters and billing, several complaints, of the same blue ribbon character as the one I just mentioned, made us change part of our meter reading procedure.

These were, that our meter readers sat in their truck or on the curb at the street corner and wrote the readings for the entire block in the meter book, presumably from memory or by guesswork. One fellow wanted to hire one of our boys for a TV appearance as "a memory expert," saying that if he could remember twenty-five or thirty numbers of the size of meter readings he was missing his calling and both of them were losing money as a result.

We knew they were subtracting previous from present readings to get the consumption, for each house on the block all at one time, which was all right with us until we saw the customer reaction to it. So we instructed our boys to make their subtractions on the spot immediately after getting the new reading.

They did, but all that came of it was that we began getting complaints about how our boys would stand over the meter box and write meter readings in the book without bothering to lift the box lid and look at the meter. One woman said they must have X-ray eyes.

Realizing we couldn't win, we decided that since we always machine check the field subtractions, before billing, we would let that be it and stop having the meter readers do the subtraction in the field altogether. If nothing else was to be gained, at least a meter route would be read more quickly than before. However, we have found that complaints about guesswork meter reading have now dwindled to the point where we rarely get any.

These two illustrations bear out what I said the other night: that no matter how unwarranted, how farfetched or unjust it might be, each complaint is caused by something we do or do not do. If we find that a change of methods will eliminate the cause of the complaint we should make every practical effort to make the change and thus remove another source of customer dissatisfaction.

Yours, Hank

*Contributed by Henry Wilkins, Distr. Mgr. Texas Water Co., Houston, Tex.

Activated Silica Preparation by Continuous Processes

by V. W. LANGWORTHY

Mr. Langworthy is Project Engineer of Omega Machine Co., Div. of B-I-F Industries, Inc., Providence, R. I. In this article he discusses the fundamental factors of continuous process preparation of activated silica.

NOW, ACTIVATED SILICA can be produced successfully on a continuous basis. Today, the time-and-space-consuming batch methods are outmoded although it must be acknowledged that continuous activation of silica by various reagents has evolved naturally from the old batch processes. Activated silica as a coagulant aid has been shown to be remarkable in its ability to assist in the clarification of warm or cold, turbid or colored surface waters. Properly prepared and applied it can reduce the load on sand filters by forming a floc which will ride out hydraulic surges in conventional or sludge blanket type clarifiers.

While the use of activated silica sol and the benefits to be derived from its use as a coagulant aid are fairly well appreciated, it is desirable to know more about additional factors involved. This paper discusses equipment requirements, operating techniques, characteristics of the common activating agents and elements entering into control of the activating process.

Equipment Requirements

It is necessary that accurate control be maintained over the raw sodium silicate and activating agent to be used in the process. For this purpose equipment of choice is a positive displacement type pump, which must have reproducible accuracy and be capable of adjustment while in operation. Capacity and range of the pump must be compatable with other items of equipment employed.

At least one water meter should be provided to establish a known concentration of raw sodium silicate and activating agent. Variable orifice meters of the rotameter type have proved satisfactory for this purpose.

The importance of *intimate* and *complete* mixing between raw sodium silicate, activating agent and dilution water cannot be over-emphasized. The success or failure of the activated silica process largely depends on efficient mixing of controlled quantities of reagents at the proper concentrations. Hydraulic, mechanical or air mixing may be selected. Air mixing, however, may introduce troublesome reactions and likely will entail the expense of auxiliary air compressing and control equipment.

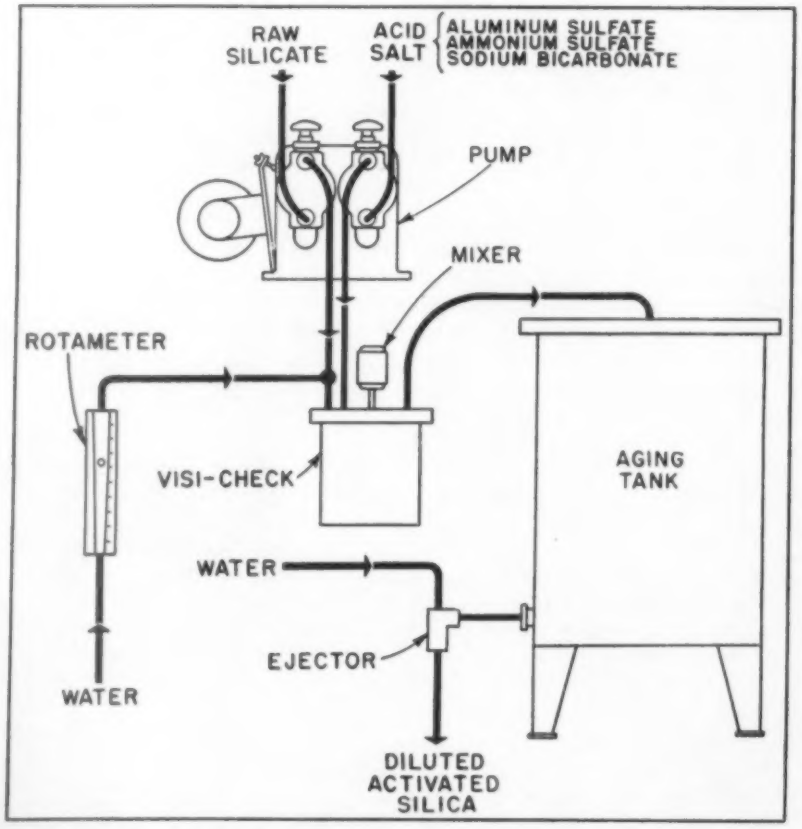


Fig. 1. FLOW diagram of continuous silica activation by acid salt.

Aging

In order that a properly prepared activated silica sol may reach its maximum activity, a period of aging must be provided. Experience in the laboratory and on plant scale has indicated that aging requirements vary with the relative strengths of activating agent used in relation to a given volume of raw sodium silicate. In general, the higher ratios of activating agent per unit volume of raw sodium silicate require less aging. It has also been observed in rare instances, that formal aging of the silica sol may not be required to im-

prove coagulation in some raw waters. To produce a sufficiently active sol for most water treatment problems it is practicable to employ an aging period of approximately ten minutes by adjusting the strength of the activating agent to the point of greatest observed effect on flocculation.

Equipment for continuous silica activation should be supplied with aging capacity. This capacity should be sufficient to retain the sol at aging concentration for ten minutes when the rated *maximum* amount of activated silica is being produced. For example, if the total volume of raw silicate solution and solution of activating agent is 10 gallons per minute, at least a 100 gallon aging capacity vessel or chamber would be required to detain the sol for a ten-minute aging period.

Adjustable features should be provided in the aging unit so that ten-minute aging can be assured at all rates of activated silica production. Inasmuch as the process is continuous, aging equipment should be designed to minimize short circuiting and permit aging time adjustment without interruption to the process.

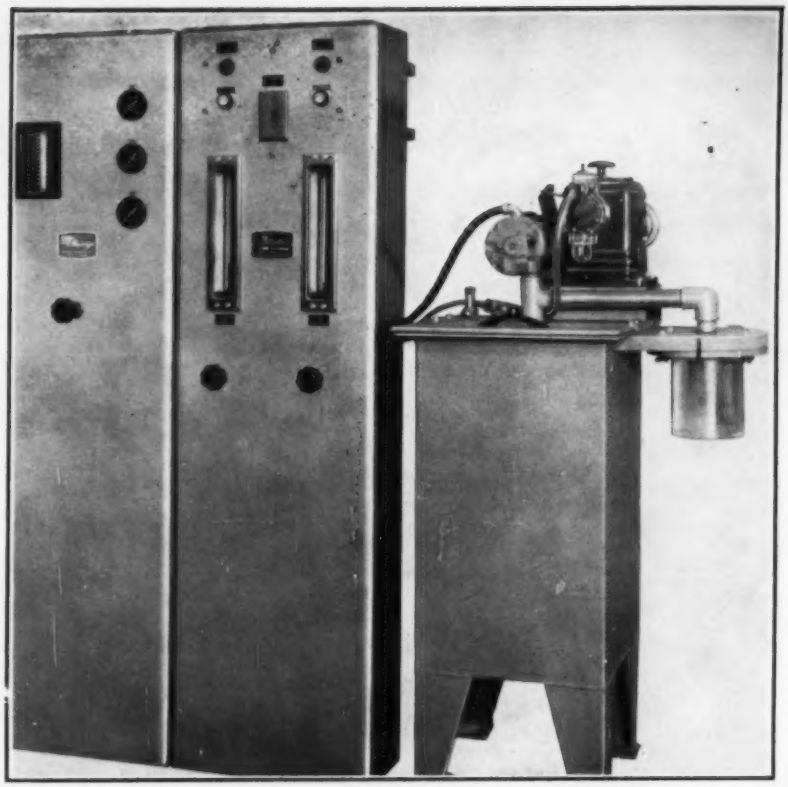


Fig. 2. CHLORINE type continuous silica activating equipment.

Constant strength chlorine device at left, control panel in center and mixing-aging system at right. Pump handles sodium silicate.

Transferral

The final item of equipment in continuous silica activation is that employed to conduct the active sol to the point of application. Gravity is the preferred means of delivery, but pumps of many types can and are being used for this purpose at numerous installations. The importance of *liberal* dilution of the activated silica sol for delivery to the point of application must be recognized. The tendency for objectional silica gel to form is virtually eliminated when the 10 minute aged sol is diluted. Therefore, the volume of sol being prepared should be diluted with an equal amount of water either for transfer or for holding purposes.

Avoiding Operating Errors

It is possible to provide certain features in continuous silica activating equipment which overcome some of the common operating errors. If water used by the equipment is required to pass through a flow switch, controlling all electrical circuitry, it becomes impossible to operate the equipment with insufficient water. This is an advantage in that it prevents starting the raw sodium silicate and activating agent flows without first turning on the diluting water supply to the unit.

Interference with the process can also be caused by failure of the raw sodium silicate pumps to deliver. Means should therefore be provided to detect this failure and to do something about it. If insufficient raw sodium silicate were delivered to the system, an excess of activating agent would result. This situation can lead to silica gel formation rapidly if allowed to continue. To avoid gelation, under this condition, it is therefore desirable either to shut off the supply of activating agent, or to provide copious amounts of rinse water automatically. An automatic rinse feature will permit resumption of normal operation merely by correcting the interference.

Automatic rinsing also eliminates the problem of human forgetfulness at shutdown time. In the event the operator shuts down the equipment, gelation is prevented by dilution effected through the automatic rinse system. This is greatly to be desired over cleaning out the system once gel has formed. Such an automatic rinse feature can be timed for a predetermined period, or the entire system can be turned off manually after rinsing. Under all circumstances, an automatic rinse arrangement should be incorporated in any continuous silica activating installation.

Selection of Activating Agent

Several acidic reagents have been used successfully for continuously activating silica. Among these are chlorine, sulfuric acid, ammonium sulfate, aluminum sulfate, sodium bicarbonate and carbon dioxide. A typical composite flow diagram for acid salts is shown in Figure 1. Ferric sulfate also has been used as an activant in at least one West coast installation.

Selection of chlorine as the activating agent is popular, because chlorine used in the activation process is also available for disinfection or other purposes. Chlorine is simple to use and is readily available in most water treatment plants. Unfortunately, the ordinary chlorine gas feeding equipment does not lend itself readily for use with silica activating devices. The reason is that the regular chlorinator injector dilutes the chlorine solution too much.

Although chlorine is a desirable activating agent, it does have shortcomings. For example, where low rates of raw water having low chlorine demand require treatment with activated silica, too much chlorine often is added by the chlorine type equipment. This is an anomaly,

wherein any reduction in chlorine used produces an inferior activated silica. Therefore, while chlorine is readily available, it will not in every case be the best reagent to use in the silica activating process. A typical chlorine activated silica unit is shown in Fig. 2.

Sulfuric acid is considered the least expensive activating reagent. Many operators, however, prefer not to handle the acid unless absolutely necessary. With adequate precautions, sulfuric acid may be used successfully at both large and small plants as a silica activant. Figure 3 illustrates a sulfuric acid type silica activator.

Ammonium sulfate is often used in connection with the chlorine-ammonia process at water treatment plants. It is also readily available in tonnage lots at reasonable prices. The technical grade product is crystalline, free flowing and possesses a high solubility in water. It is a good activating agent where small amounts of ammonia will not interfere in the treatment process, or with subsequent water uses.

Aluminum sulfate has enjoyed widespread use as a coagulant in water treatment plants in this country. It is readily available and easy to handle, These characteristics plus its good solubility render it highly desirable as an activating agent. It should be noted, too, that a portion of the alum used in the activation process remains available as aluminum hydroxide for use as a coagulant.

Sodium bicarbonate is an inexpensive reagent highly satisfactory for use as an activant. It has a comparatively low solubility in water which makes it less suitable than the acid salts already mentioned. The weak acid tendency, however, provides a process which is easy to control because of the high buffering action of the bicarbonate. Also, the tendency to gel is less dominant in the bicarbonate process than in the alum or ammonium sulfate methods.

Carbon dioxide has been used successfully in batch-wise preparation of activated silica. Its adaptation to continuous processes has been limited primarily due to its low solubility in water. The gas is not readily available at economical prices in tonnage lots, nor is the solid product (dry ice) easily adaptable for use. At least one Florida installation uses flue gas as a source of carbon dioxide, but this practice has not become widespread.

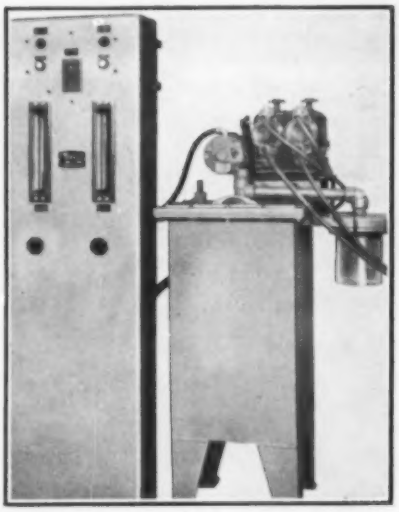


Fig. 3. SULPHURIC acid type continuous silica activating equipment.

Activating agent selection should be made, in part, on the basis of the reagent which produces the best coagulant aid, helpful in solving the local coagulation problem. Many plant operators use jar tests as a means of selecting appropriate coagulant dosage. The same test will indicate the silica activating agent best suited to local raw water conditions.

Interchangeability of activating agents is simplified when dry reagents are used. The problem is simply one of selecting the chemical, dissolving it and delivering the proper volume of constant strength solution to the mixing and aging equipment. Equipment used in feeding gaseous reagents does not possess this flexibility.

Process Control

Silica activation may be considered a neutralization reaction. The end product sought is a controlled suspension of colloidal silica. It should be possible to control the activation process by titration, gel time, pH, conductivity, viscosity, or light transmittancy. It has been found that titration is a reliable means of control. Total alkalinity of the aged sol will depend on the activating agent used.

Where chlorine is the activating agent, the titration for available chlorine may be used as a guide. In the acid salt reactions straight titrations for total alkalinity may be used. The objective is to obtain the best sol short of gel formation. This means that the titration end point selected should give a gel time longer than the aging period required by the activating equipment.

Gel time can be used as a means of determining the aging period, no other tests being required. The gel time for certain type sols may be extremely long, rendering the results obsolete by the time they are obtained. Short gel time, such as that obtained where chlorine or sulfuric acid is used, is more appropriate for use as a guide. Gel time remains valuable usually as a check against the easily performed and reliable titration.

The remaining control procedures, pH, conductivity, viscosity, and transmittancy all have application where precise study and exhaustive data are desired. However, the normal operation of activated silica equipment does require or justify expenditure for the necessary instruments required for these tests.

In Summary

Continuous silica activation requires dependable equipment accurately calibrated if satisfactory results are to be obtained. The process should include efficient mixing and provision for control over the aging period. It is desirable to include automatic interlocks to guard against improper start-up and to provide rinsing at shutdown. While these features are not mandatory, they contribute an intangible peace of mind to the operator and are insurance against non-performance.

Ideally, the silica activating equipment should provide for interchangeability of activating agents. This feature allows the operator freedom of choice of activant both before and after equipment purchase. Activant selection should be based primarily on the results produced; secondary considerations, however, are availability, safety, economy and chemical characteristics.

The activation process may be controlled in several ways. Titration and gel time have proved to be the most practical means available.

EXPANDED sewage treatment plant at Austin, Texas, is compact but efficient

Experiences with the Austin, Texas

"Biosorption" Plant

A new development in activated sludge

by A. H. ULLRICH

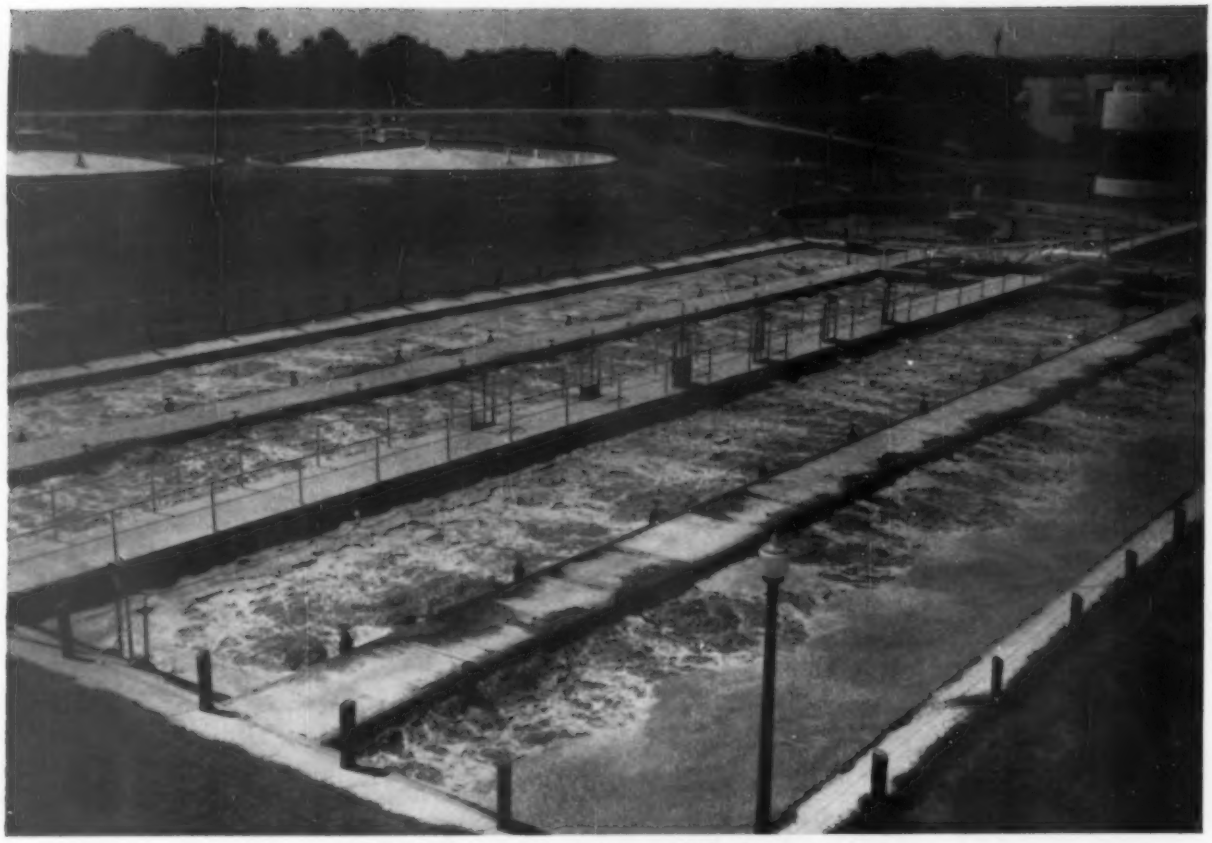
Mr. Ullrich is Superintendent of Water and Sewage Treatment at Austin, Texas, where this innovation in activated sludge was first developed. His account of the original studies and conversion of a large plant to the process should be of interest to many.

PRIOR TO 1937 Austin's sewage was treated in Imhoff tanks. During 1935 and 1936 an activated sludge plant was constructed at the location of the existing plant. This plant was designed to give complete treatment by the conventional activated sludge process to a 6.0-mgd. average raw sewage flow.

Although the plant design was based on the best data then available, good operation was difficult to attain and results were frequently poor. Plant records show that the plant was plagued with bluking sludge and other troubles. Also, although the plant design contemplated return of the excess activated sludge to the primary clarifier and return of the digester supernatant to the aeration tanks, neither worked successfully. Operational difficulties became so bad that from October 1946 to December 1947 only plain aeration was used. Fortunately, because of adequate dilution in the receiving stream, no serious difficulties were encountered by the city.

Immediately following World War II, Austin experienced a rapid growth and by 1947 the raw sewage flow had increased to approximately 9.0 mgd. Not only had the conventional 6.0-mgd. activated sludge plant become overloaded, but the discharge of excessive amounts of poorly treated waste into the Colorado River also was causing complaints from property owners downstream from the plant.

Consequently, it was decided to resume operation by the activated sludge process to determine, if possible, what was needed in the way of plant expansion to adequately treat all of the sewage flow. Actual operation by the activated sludge process was resumed in December 1947. Immediately thereafter the writer and Mansel W. Smith, Plant Superin-



AERATION tanks used for sludge stabilization and mixing

tendent, began intensive studies in the hope of finding new operational procedures which would permit the then existing plant to treat larger flows and greater loads and still maintain a good effluent quality with a minimum of plant upsets.

Development of Biosorption Process

Among the several laboratory and plant studies which were carried on simultaneously, one involved a study of the behavior and characteristics of mixed liquor at progressive stages during its flow through an aeration tank. The aeration tank used for the study was operated under a 4-hour detention time based on average sewage flow plus 35 percent return sludge rate.

Sampling stations were set up along the aeration tank at locations which represented 15- to 30-minute detention time and detention times of 1, 2, 3 and 4 hours. The last station was, of course, near the tank outlet. Samples of mixed liquor were collected at all stations. These were all permitted to settle the same length of time and B.O.D. and suspended solids tests were made on the supernatant liquor.

In each series of tests the settling characteristics and the B.O.D. and suspended solids reductions at the 15- to 30-minute sampling station were equal to or better than at any of the other stations, including the station at the outlet end of the tank. The results were best at the first station, became poorer toward the halfway point, and improved toward the outlet end of the tank where they again approached the low values obtained at the first station.

The high B.O.D. and suspended solids reductions at the 15- to 30-minute sampling station were due, of course, to the excellent absorptive capacity of activated sludge. There was also the fact that the sludge obtained from settling of the mixed liquor at this station consisted of the return activated sludge plus the absorbed suspended and dissolved pollutional matter from the sewage and that it would not be stable.

It was thought, however, that if this sludge could be reactivated by giving the organisms in the original activated sludge an opportunity to aerobically digest the absorbed pollutional matter, it could be used for recycling on a continuous process basis. It was apparent that if the B.O.D. or pollutional matter in sewage could be concentrated by absorption on activated sludge, the resulting sludge settled and removed from the sewage, and then successfully oxidized or reactivated in a separate tank or compartment, a considerable saving in aeration tank capacity would be possible.

To describe the idea for thus using the high absorption capacity of activated sludge for quickly removing pollutional matter from sewage the word "Biosorption*" was coined. Briefly, the idea was to mix activated sludge with raw sewage for a short period (in the order of 15 to 30 minutes), settle the mixture (mixed liquor), discharge the overflow from the settling tank as final effluent, pump the settled sludge to an aeration tank for stabilization and reactivation and thus make it available for again mixing with raw sewage.

To test the concept on a continuous process basis a very flexible pilot plant having a capacity of from 15 to 20 gpm of raw sewage was built. The essential units of the pilot plant were a mixing tank for brief mixing of sewage with activated sludge, a clarifier for settling out the sludge

*The word "BIOSORPTION" has been adopted by Infilco, Inc., to designate its equipment for treatment of waste liquids by the process described hereafter, and is a registered trade-mark of Infilco, Inc.

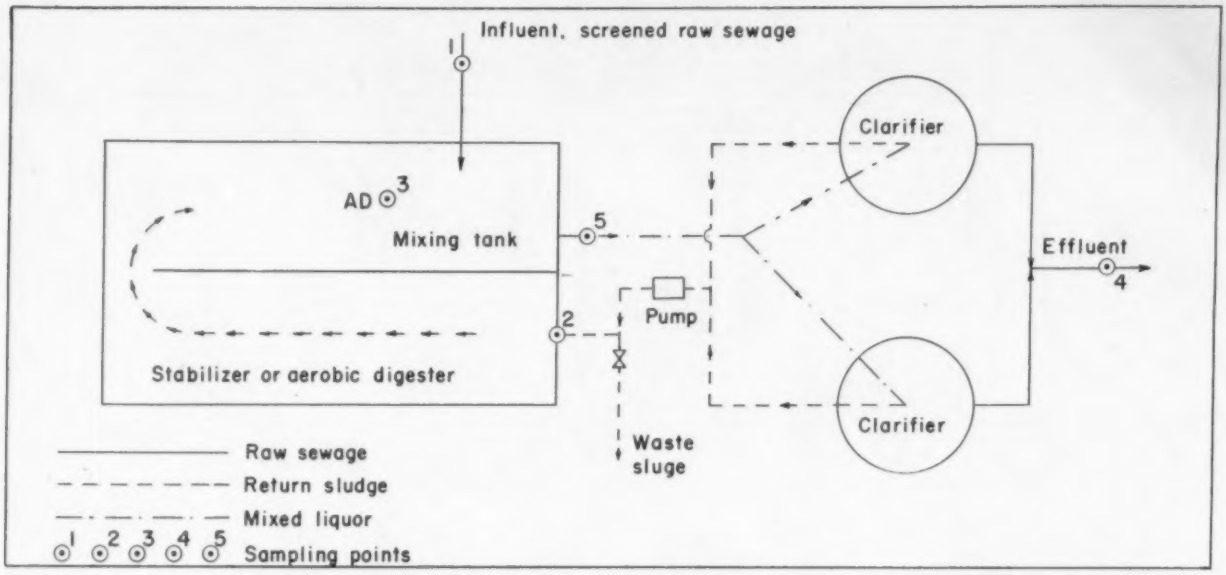


Fig. 1—FLOW DIAGRAM for plant-scale test using existing plant structures and equipment

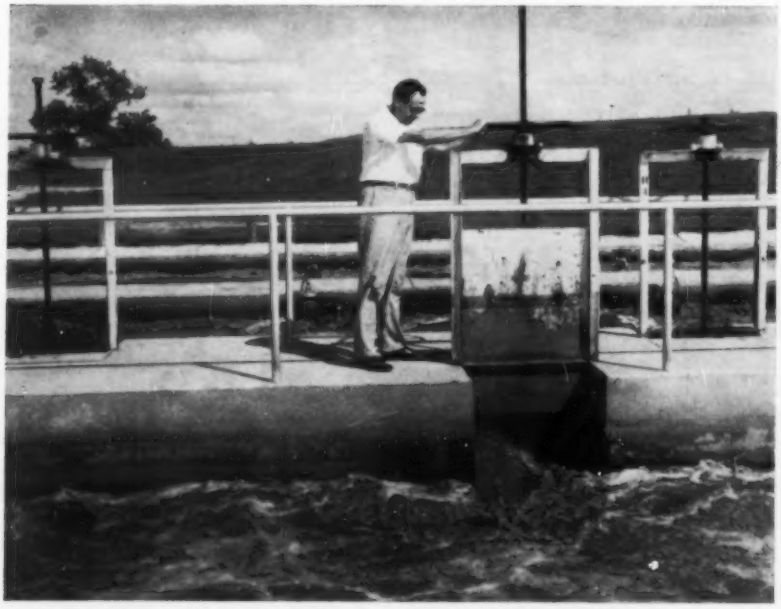
from the mixing tank, an aeration tank for reactivating the settled sludge, and such necessary auxiliary equipment as air supply and air diffusers, sludge pump, and the necessary piping.

The pilot plant was operated during a 15-month period beginning early in 1950 and extending into 1951. It was operated under widely varying conditions of mixing and sludge aeration retention periods, to establish design data to be used in large-plant design. B.O.D. and suspended solids reductions of 90 to 96 per cent were consistently obtained on raw sewage which had average B.O.D. and suspended solids concentrations of 243 and 230 ppm, respectively. The efficiency of the plant varied from extremes of 86 to 96.4 per cent. In almost every case of low efficiency the cause could be traced to partial clogging of the return sludge line, which was of necessity small in order to control the low flow rates used. More complete data on the pilot plant operation were published by Ullrich and Smith in *Sewage and Industrial Wastes*, Vol. 23, No. 10, Oct. 1951.

The pilot plant test showed that the new process not only was feasible but also actually produced better results with the Austin sewage than could be obtained with the conventional activated sludge process. It also established the fact that by converting the large plant to the new process the existing aeration tanks would have adequate capacity to treat more than twice the amount of sewage formerly possible by the conventional activated sludge method.

To further test the concept, one-half of the large plant was converted to a "Biosorption" plant on a temporary basis in April 1951. Fortunately, the large plant had been designed for maximum flexibility and to make the temporary conversion required nothing more than the installation of a 24 inch concrete line above ground to conduct screened and degritted raw sewage directly into one of the two aeration tanks near the tank outlet (Figure 1). The point of discharge of the raw sewage line was such as to give 20- to 30-minute mixing of raw sewage with stabilized active sludge before the resulting mixed liquor flowed to the clarifiers for settling.

The overflow from the clarifiers became the final effluent. The settled sludge, which contained the previous active sludge plus the absorbed pollutional matter from the sewage, was continuously returned to the inlet end of the aeration tank for stabilization and reactivation during its flow back to the mixing zone of the aeration tank. It should be noted that in the pilot plant operation separate tanks were provided for mixing the raw sewage with activated sludge and for sludge stabilization, while in the plant —scale test approximately 80 per cent of the first part of the aeration tank



OPEN sluice gate through which raw sewage enters mixing zone

TABLE I

Plant-Scale Test, May 1951, Austin, Texas, Biosorption Plant

Date	Day of Week	Raw Sewage, mgd	Percent Return Sludge	Air, cu. ft./gal.	B. O. D., ppm.			Suspended Solids, ppm.						Sludge Index	D. O., Final Effluent, ppm.	Turbidity, Final Effl., ppm.
					Raw Sewage (1)	Final Effluent (4)	Reduction, %	Raw Sewage (1)	Final Effluent (4)	Reduction, %	A.D. (Aeration) (3)	Return Sludge (2)	Mixed Liquor (5)			
1	T	8.293	37.4	0.70	200	24.0	88.0	205	20.4	90.0	4680	7700	2530	165	0.5	10
2	W	8.160	35.7	0.75	300	31.2	89.6	223	20.8	90.7	4930	8950	2870	227	0.4	11
3	T	7.648	37.6	0.94	300	24.0	92.0	222	20.0	91.0	6110	9240	3500	202	0.0	10
4	F	7.174	39.7	1.00	—	—	—	—	—	—	—	—	—	—	Tr.	—
5	S	7.028	39.1	1.03	—	—	—	—	—	—	—	—	—	—	—	—
6	S	7.379	41.3	0.93	180	7.2	96.0	165	5.2	96.8	5710	8740	3840	179	—	3
7	M	7.162	41.3	1.01	220	9.6	95.6	220	15.6	92.9	6320	10000	3930	156	1.0	7
8	T	7.058	43.2	1.02	240	12.0	95.0	224	6.0	97.3	6820	10300	4120	178	0.3	11
9	W	7.090	44.0	1.02	260	19.2	92.6	234	16.4	93.0	6860	9500	4180	163	0.8	8
10	T	7.159	43.5	1.01	240	14.4	94.0	207	17.2	91.7	6180	9500	3920	182	0.5	7
11	F	7.206	36.4	1.00	—	—	—	—	—	—	—	—	—	—	0.6	—
12	S	6.902	37.1	1.04	—	—	—	—	—	—	—	—	—	—	0.8	—
13	S	7.292	35.2	0.99	170	8.4	95.1	169	6.4	96.2	4660	7560	2760	157	—	5
14	M	7.115	36.1	1.01	200	9.6	95.2	253	10.0	96.0	3940	6400	3060	147	1.1	5
15	T	7.215	35.1	1.00	260	15.6	94.0	256	6.4	97.5	4430	7840	2680	122	1.9	5
16	W	7.620	34.1	0.94	220	10.8	95.1	203	8.8	95.7	4910	7640	2830	122	2.8	4
17	T	7.897	32.8	0.91	220	8.4	96.2	233	8.0	96.6	4890	8090	2850	107	2.8	2
18	F	8.325	31.5	0.86	—	—	—	—	—	—	—	—	—	—	1.8	3
19	S	8.334	30.9	0.86	—	—	—	—	—	—	—	—	—	—	0.8	—
20	S	8.179	30.6	0.88	200	12.0	94.0	173	8.0	95.4	4760	8140	2530	127	0.8	3
21	M	7.818	32.7	0.92	200	14.4	92.8	256	21.6	91.6	4190	6050	2620	113	0.6	9
22	T	7.373	34.7	0.98	240	24.0	90.0	200	12.0	94.0	4370	9650	2590	145	Tr.	8
23	W	8.705	29.7	0.83	220	14.4	93.5	244	14.8	93.9	4350	8240	2480	144	0.3	9
24	T	8.009	33.3	0.90	290	27.6	90.5	216	24.0	88.9	4460	7500	2440	148	1.2	15
25	F	7.272	34.9	0.99	—	—	—	—	—	—	—	—	—	—	1.4	—
26	S	7.504	33.8	0.96	—	—	—	—	—	—	—	—	—	—	—	—
27	S	7.218	35.4	1.00	170	8.4	95.1	182	10.8	94.1	4400	7860	3250	182	—	6
28	M	7.281	34.9	0.99	260	16.8	93.5	244	9.6	96.1	3520	6700	2940	133	1.3	9
29	T	7.382	35.1	0.98	200	9.6	95.2	208	13.2	93.7	5130	8580	3020	142	0.3	7
30	W	7.428	34.6	0.97	260	12.0	95.4	220	16.0	92.7	5260	7320	3210	164	0.5	4
31	T	7.261	35.4	0.99	210	4.8	97.7	230	10.8	95.3	5290	7610	3010	178	0.6	3
Avg.		7.532	35.9	0.95	229	14.7	93.6	217	13.1	94.0	5052	8257	3094	164	0.9	7
Max.		8.334	44.0	1.04	300	31.2	97.7	256	24.0	97.5	6860	10300	4180	227	2.8	15
Min.		6.902	29.7	0.70	170	4.8	88.0	165	5.2	88.9	3520	6700	2440	107	0.0	2

Retention based on average flow:

Mixer	31 min.
Stabilizer	2.7 hr.
Clarifier	2.4 hr.

Retention based on actual throughput:

Mixer	23 min.
Stabilizer	7.5 hr.
Clarifier	1.8 hr.

All tests except D. O. made on 24-hour composite samples.

capacity was used for a sludge stabilization zone and the remainder of the tank, toward the outlet end, was used for the mixing zone.

The plant-scale test on the temporary conversion basis was carried on for more than two years. The results confirmed those obtained from the pilot plant test. Tables 1 and 2 give results obtained during a typical two-month period. It will be noted that during May 1951 the maximum B.O.D. reduction was 97 per cent, the minimum was 88.0 per cent, and the average was 93.6 per cent.

It also will be noted that the final effluent B. O. D. ranged from a low of 4.8 to a high of 31.2 ppm, with an average of 14.7 ppm. The average raw sewage B.O.D. was 229 ppm and the air required averaged only 0.95 cu ft per gallon of raw sewage.

During June 1951 the B.O.D. reductions were even better. The maximum reduction was 98.8 per cent, the minimum was 93.6 per cent, and the average was 95.5 per cent. The suspended solids reductions were in the same range as the B.O.D. reductions. It also will be noted that an average flow of approximately 7.5 mgd was treated with one aeration tank, whereas the plant was originally designed for use of two identical aeration tanks for a 6.0-mgd average flow when operating by the conventional activated sludge method.

Expansion and Conversion of Plant

Because the plant-scale test gave excellent results from the very beginning, plans were immediately made for conversion and enlargement of the entire plant to the new process. However, due to delays in deliveries of equipment purchased in 1951 and due to construction delays, the first phase of the plant expansion and conversion was not completed until March 11, 1954. It was placed in permanent operation on March 28, 1954.

The original activated sludge plant had one bar screen, one grit removal unit, one primary clarifier, two aeration tanks, two final clarifiers, two two-stage digesters and the necessary auxiliary equipment such as blowers, pumps, meters, etc. The two aeration tanks and the two final clarifiers were operated in parallel.

To use these units to the best advantage after conversion to a "Biosorption" plant, the primary clarifier was converted to a final clarifier to operate in parallel with the two orig-

TABLE 2

Plant-Scale Test, June 1951, Austin, Texas, Biosorption Plant

Date	Day of Week	Raw Sewage, Mgd.	Percent Return Sludge	Air, cu. ft./gal.	B. O. D., ppm.			Suspended Solids, ppm.						Sludge Index	D. O., Final Effluent, ppm.	Turbidity, Final Effl. ppm.
					Raw Sewage (1)	Final Effluent (4)	Reduction, %	Raw Sewage (1)	Final Effluent (4)	Reduction, %	AD. (Aeration) (3)	Return Sludge (2)	Mixed Liquor (5)			
1	F	7.253	35.3	0.99	—	—	—	—	—	—	—	—	—	—	—	—
2	S	7.412	31.6	0.97	—	—	—	—	—	—	—	—	—	—	—	—
3	S	7.942	32.5	0.91	160	8.4	94.8	230	6.4	97.2	4700	8160	2800	134	—	2
4	M	7.209	35.5	1.00	150	4.8	96.8	176	9.6	92.4	4610	6220	2640	104	3.3	3
5	T	7.382	35.3	0.98	100	9.6	94.7	121	6.0	95.0	4000	6670	2610	96	2.4	2
6	W	7.343	34.2	0.98	190	4.8	97.5	200	9.2	95.4	3960	7160	2770	116	2.7	2
7	T	7.489	34.0	0.96	200	2.4	98.8	184	5.2	97.2	4000	6000	2660	117	2.6	2
8	F	7.317	34.6	0.98	—	—	—	—	—	—	—	—	—	—	1.8	—
9	S	7.420	35.1	0.97	—	—	—	—	—	—	—	—	—	—	—	—
10	S	7.281	35.8	0.99	140	8.4	94.0	160	1.6	99.0	4000	5810	2200	157	—	2
11	M	7.548	31.3	0.96	230	10.8	95.3	185	1.6	99.1	4290	5630	2190	149	0.8	2
12	T	7.568	33.6	0.92	205	13.2	93.6	223	7.2	96.8	4130	7630	2400	193	0.8	3
13	W	7.712	32.9	0.91	190	3.6	98.1	165	5.2	96.8	3730	6290	2440	156	1.2	2
14	T	8.033	31.3	0.90	—	—	—	—	—	—	—	—	—	—	—	—
15	F	7.544	34.1	0.95	—	—	—	—	—	—	—	—	—	—	—	—
16	S	7.683	33.2	0.95	—	—	—	—	—	—	—	—	—	—	—	—
17	S	7.524	34.3	0.96	140	3.6	97.4	159	2.8	98.2	3600	4770	2210	178	—	2
18	M	7.422	34.3	0.97	220	8.4	96.2	210	8.0	96.2	3770	6270	2220	159	1.3	5
19	T	7.083	35.7	1.02	240	12.0	95.0	186	8.0	95.7	3600	5850	2300	187	0.4	5
20	W	7.159	39.6	1.01	240	12.0	95.0	255	4.8	98.1	3760	4550	2270	211	0.4	4
21	T	7.125	35.9	1.01	210	9.6	95.4	212	9.6	95.5	3730	5330	2260	216	0.5	3
22	F	7.100	36.0	1.01	—	—	—	—	—	—	—	—	—	—	0.5	—
23	S	7.011	40.9	1.03	—	—	—	—	—	—	—	—	—	—	—	—
24	S	6.632	43.8	1.09	180	9.6	94.7	162	8.0	95.1	4040	6750	3000	123	—	2
25	M	6.950	41.1	1.04	200	9.6	95.2	193	12.8	93.4	4170	6700	2430	131	0.6	4
26	T	7.499	38.5	0.96	240	12.0	95.0	196	11.6	94.1	4110	6280	2310	119	0.6	7
27	W	7.450	38.4	0.97	220	13.2	94.0	194	12.4	93.6	4230	5510	2740	193	0.8	7
28	T	7.267	42.4	0.99	230	10.8	95.3	190	12.0	93.7	4000	5240	3700	129	1.0	7
29	F	7.597	37.8	0.95	—	—	—	—	—	—	—	—	—	—	1.0	—
30	S	7.595	37.3	0.95	—	—	—	—	—	—	—	—	—	—	1.0	—
Avg.		7.387	36.0	0.97	198	8.8	95.6	187	7.5	96.0	4028	6310	2522	156	1.2	3
Max.		8.033	43.8	1.09	240	13.2	98.8	255	12.4	99.1	4700	8460	3700	216	3.3	7
Min.		6.632	31.7	0.90	140	2.4	93.6	121	1.6	92.4	3600	4550	2210	96	0.4	2

Retention based on average flow:

	June 1-26	June 27-30
Mixer	31 min.	52 min.
Stabilizer	2.75 hr.	2.3 hr.
Clarifier	2.5 hr.	2.3 hr.

Retention based on actual throughput:

	June 1-26	June 27-30
Mixer	23 min.	38 min.
Stabilizer	7.7 hr.	6 hr.
Clarifier	1.8 hr	1.8 hr.

All tests except D. O. made on 24-hour composite samples.

inal clarifiers. One of the aeration tanks was then converted to operate with these three clarifiers as a "Biosorption" plant unit. Two additional large clarifiers were constructed to operate with the second aeration tank as a Biosorption plant unit. The principal units installed during the plant expansion and conversion are as follows:

1—Blower building to house additional blowers, sludge pumps, etc.

1—Mechanically cleaned bar screen to operate in parallel with the original bar screen.

1—Grit removal unit to operate in parallel with the original grit removed unit.

2—Final sedimentation tanks (clarifiers), 85 ft dia by 10 ft side water depth.

2—Blowers, positive displacement, 4,650-cfm capacity each.

Auxiliary equipment, including new pumping units for scum, return sludge, and excess sludge; new air filters; meters on all new air and liquid lines; etc.

TABLE 3

Annual Average 5-Day B.O.D.'s on Austin Raw Sewage

Year	B. O. D., ppm.
1945	280
1946	218
1947	219
1948	267
1949	278
1950	215
1951	232
1952	226
1953	257
1954	281
1955	305

In addition to the foregoing, the raw sewage conduit was extended from the grit removal units to the aeration tanks, the fixed diffuser plates in the aeration tanks were replaced with diffuser tubes, the original primary clarifier was converted to a final clarifier, skimming devices were installed on the original final clarifiers, and new draft tube mixers were installed in the primary digesters. The cost of the plant expansion and conversion, including all new equipment and structures was approximately $410,000.

Expansion and conversion of the plant has increased its design capacity of 6.0-mgd average flow when operating on the conventional activated sludge process to 14.0 to 16.0 mgd average flow when operating as a "Biosorption" plant. It is signifi-

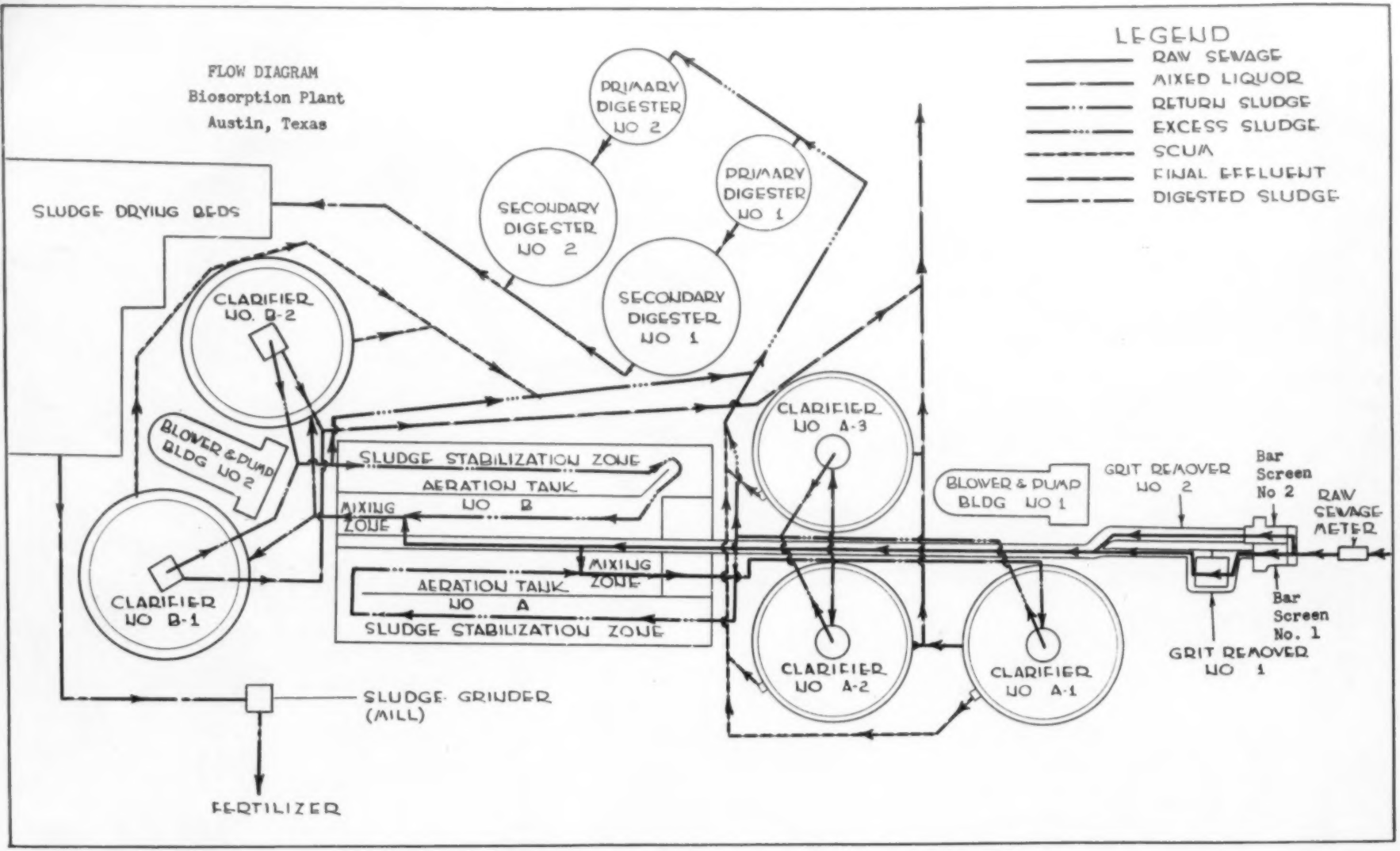


Fig. 2—FLOW DIAGRAM of expanded Austin plant using "Biosorption" process

cant that this increase in capacity has been obtained without the addition of any aeration tank capacity and by eliminating the need for the primary clarifier, thus making it available for use as a final clarifier. It is estimated that the conversion of the plant resulted in a saving in excess of $200,000 for this one expansion alone.

Figure 2 gives a flow diagram of the plant after expansion and conversion to a "Biosorption" plant. It will be noted that the plant is divided into units "A" and "B". The plant is operated as two separate plants, the raw sewage being divided between the two plant units. Plant "A" consists of one aeration tank and the old clarifiers; plant "B" consists of the other aeration tank and the new clarifiers.

Operating Experience

The results obtained since conversion of the entire plant to "Biosorption" have been very gratifying, particularly because the sewage has been rather strong. As previously noted, Austin's sewage was always difficult to treat by the conventional activated sludge method. Although Austin is known as a residential city with few large industries, its sewage often has been pretty "rough" for a purely domestic sewage. Since the early 1930's Austin has operated a large municipal abattoir, from which large quantities of blood, paunch contents, grease and other normal packinghouse wastes have been discharged into the sanitary sewer without benefit of prior treatment.

In addition to the abattoir there are several large poultry processing plants and a large chili manufacturing plant, from which undetermined quantities of waste are received. In recent years, Austin also has become the home of a number of small chemical manufacturing plants, from which toxic wastes have frequently been discharged into the sanitary sewers.

The strength of Austin's sewage fluctuates over a rather wide range. Hourly 5-day B.O.D. tests on grab samples may vary from a low of about 15 ppm to values in excess of 900 ppm. Monthly averages of 5-day B.O.D. tests made on 24-hour composite samples have varied from a low of 187 ppm in May 1952 to a high of 358 ppm in January 1956. Since late in 1954 there have been many days when the composite samples showed B.O.D.'s between 400 and 500 ppm. Table 3 gives annual average 5-day B.O.D.'s on 24-hour composite samples of raw sewage.

The fluctuations in the strength of the raw sewage probably are due, in great measure, to infiltration or to a lack of it. The rainfall in Austin has been considerably below normal since 1947 and the last few years have been exceptionally dry. Regardless of the reasons for these fluctuations it is of interest that the "Biosorption" plant

TABLE 4

Plant "A" at Full-Plant Operation, January 1956

Date	Day of Week	Raw Sewage, m.g.d.	Percent Return Sludge	Air, cu. ft. gal.	B. O. D., ppm.			Suspended Solids, ppm.					Sludge Index	D.O., Final Effl., ppm.
					Raw Sewage	Final Effluent	Reduction, %	Raw Sewage	Final Effluent	Production, %	Return Sludge	Mixed Liquor		
1	S	5.652	63.7	1.36	—	—	—	—	—	—	—	—	—	—
2	M	6.476	55.6	1.66	390	19.2	95.1	230	22.0	90.4	8900	2430	106	—
3	T	6.324	56.9	1.89	410	20.4	95.0	242	26.0	89.2	7830	2670	106	0.8
4	W	6.576	54.7	2.06	390	20.4	94.7	261	21.0	92.0	7090	2700	100	1.2
5	T	5.574	64.6	2.58	378	16.8	95.6	290	26.0	91.0	7350	2780	106	0.8
6	F	6.323	56.9	2.35	—	—	—	—	—	—	—	—	—	0.0
7	S	5.835	61.7	2.40	—	—	—	—	—	—	—	—	—	—
8	S	5.716	63.0	2.52	245	15.6	93.6	206	20.0	90.3	6540	2600	90	—
9	M	6.623	54.4	2.19	388	26.6	93.1	270	22.0	91.9	6380	2720	78	0.8
10	T	7.166	50.2	1.95	340	25.4	92.5	237	18.0	92.4	6300	2760	72	0.4
11	W	7.072	50.9	2.10	446	13.2	97.0	210	16.0	92.4	7060	2720	76	1.2
12	T	7.020	51.3	2.11	370	19.2	94.8	234	17.0	92.7	6750	2770	66	1.0
13	F	6.247	57.6	2.31	—	—	—	—	—	—	—	—	—	0.0
14	S	5.961	60.4	2.42	—	—	—	—	—	—	—	—	—	—
15	S	6.371	56.5	2.28	260	14.9	94.3	195	17.0	91.3	5410	2620	67	—
16	M	6.453	55.8	2.27	395	26.4	93.3	267	20.0	92.5	7170	2610	59	0.4
17	T	6.497	55.4	2.25	420	30.0	92.9	282	22.0	92.9	6800	2720	50	1.0
18	W	8.091	44.5	1.80	420	14.9	96.4	232	20.0	91.4	6450	2690	42	2.0
19	T	8.044	44.8	1.79	460	24.0	94.8	220	19.0	91.4	7160	2030	54	3.0
20	F	7.623	47.2	1.89	—	—	—	—	—	—	—	—	—	1.2
21	S	6.364	56.6	2.29	—	—	—	—	—	—	—	—	—	—
22	S	6.784	53.1	2.13	220	14.4	93.5	204	18.0	91.2	6330	2340	44	—
23	M	7.071	50.9	2.01	370	24.2	93.5	280	22.0	92.1	6800	2270	42	2.0
24	T	6.456	55.8	2.26	380	25.2	93.4	270	25.0	90.7	6720	2270	47	0.8
25	W	7.010	51.4	2.10	320	24.0	92.5	288	27.0	90.6	7550	2290	45	1.4
26	T	6.428	56.0	2.31	498	23.5	95.2	273	26.0	90.5	7960	2440	42	1.6
27	F	6.629	54.3	2.25	—	—	—	—	—	—	—	—	—	1.2
28	S	5.348	67.3	2.76	—	—	—	—	—	—	—	—	—	—
29	S	5.062	71.1	2.91	210	15.6	92.6	220	15.0	93.2	6700	2540	51	—
30	M	6.150	58.5	2.38	298	20.4	93.2	250	21.0	91.6	6150	2290	48	1.6
31	T	6.920	52.0	2.08	270	18.0	93.3	265	23.0	91.3	6780	2460	50	1.2
Avg.		6.512	55.9	2.18	358	20.6	94.1	247	21.0	91.5	6917	2533	66	1.1
Max.		8.091	71.1	2.91	498	30.0	97.0	288	27.0	93.2	8900	2780	106	3.0
Min.		5.062	44.5	1.36	210	13.2	92.5	195	15.0	89.2	5410	2030	42	0.0

Average retention based on actual throughput: Mixer 38 min. Stabilizer 5.2 hr. Clarifier 2.6 hr.

EFFLUENT flume of final clarifier shows clarity of product

worked well on a pilot plant scale during 1950 and 1951 when the raw sewage B.O.D.'s were low; that it worked well (see Tables 1 and 2) on a plant-scale test during 1951, 1952 and 1953 when the raw sewage B.O.D.'s had increased; and that it has worked well (see Tables 4 and 5) since 1954, when the entire plant was converted, and when the strength of the sewage has been exceptionally high.

Experience with the "Biosorption" plant, under widely varying conditions, leads to the following pertinent observations and conclusions:

1. The volume (percent) and concentration of the sludge conducted from the clarifier to the sludge stabilization zone of the aeration tank are comparable to the volume and concentration of the return sludge in the conventional process. Sufficient sludge must be returned, of course, to assure maximum absorption and adsorption of pollutional matter from the sewage. If desired, the return rate can be maintained continuously at the maximum required for peak flows and peak loads with no apparent detrimental effect. This may simplify operational control in small plants.

2. The mixed liquor in the "Biosorption" plant has better settling characteristics than the mixed liquor had when the plant was operating under the conventional activated sludge process. The sludge index (Mohlman's) usually varies from about 50 to about 150.

3. No sludge bulking has been experienced with the converted plant. It is believed that one reason for this is that the sludge organisms absorb large quantities of food just prior to settling. It also is likely that this feeding during the brief mixing encourages the rapid start of new growth, which makes for a good settling sludge.

4. The volume and concentration of excess sludge produced is comparable to that obtained from conventional activated sludge operation. The excess sludge may be wasted either from the bottom of the clarifier or from the sludge aeration zone in the aeration tank. Laboratory tests on excess sludge drawn from the bottom of the clarifier indicate that it will digest more readily than stabilized sludge.

5. Any of the methods used for disposal of excess activated sludge from conventional activated sludge plants should work equally well or better with excess "Biosorption" plant sludge.

6. Frothing has not been experienced, except during a few short periods when toxic wastes were recieved from a chemical plant.

7. Formation of a greasy froth on the aeration tanks has been experienced during periods when the raw sewage content has been exceptionally high. This has not been particularly troublesome except during a few short periods when toxic chemical wastes were received at the same time the grease content was unusually high. During such periods there has been some greasy solids flotation in the clarifiers, which severely loaded the skimming equipment. At no time, however, has this condition seriously affected the plant efficiency.

In this connection, it again should be pointed out that the Austin "Biosorption" plant is being operated on raw sewage which has passed through bar screens and grit removal units only, and has had neither primary sedimentation nor skimming. Therefore, the final clarifiers (the only clarifiers in the plant have been equipped with skimmers in order to remove the scum which primary clarifiers would normally remove in conventional activated sludge plant operation.

As regards the grease content of the raw sewage, a study is being made of the feasibility of installing a grease removal unit at the municipally-owned abattoir, which now discharges its wastes into the sanitary sewers without first passing through a grease trap. Grease analyses on 27 recent composite samples of raw sewage as received at the plant showed an average grease content of 71.9 ppm, a maximum of 104.8 ppm and a minimum of 42.0 ppm. All of the samples low in grease content were collected on Sundays.

8. The "Biosorption" plant is much less affected by slugs of toxic wastes and by short periods of excessive loading than was the case with conventional activated sludge operation. The sludge stabilization zone always contains large quantities of solids, either active or in the process of being reactivated. When slugs of toxic wastes are received, only that part of the active sludge which comes in contact with the active material in the mixing zone is seriously affected. For this reason recovery is rapid after the slug has passed. Recovery can be hastened if that portion of the sludge which was contaminated is wasted.

9. The process has been found to be much less tempermental and much less subject to upset than the conventional process. The large quantities of solids carried in the sludge stabilization zone are believed to make the process capable of adjusting itself more readily to variations in the characteristics of the sewage received.

10. The process works best when a low sludge blanket is carried in the clarifiers. The Austin plant practice is to carry a sludge depth of less than 4 feet, preferably about 2 feet, at the walls of the center feed clarifiers. This is easily accomplished because of the good settling characteristics of "Biosorption" plant sludge. Austin experience with the conventional process indicates that it also works best when a low sludge blanket can be carried.

11. Experience has shown the air requirement for the "Biosorption" plant to be about the same as for a conventional activated sludge plant. Sewages and wastes having low B.O.D.'s will have low air requirements; those with high B.O.D.'s will have higher air requirements. Freese[1] has observed that in conventional

TABLE 5

Monthly Averages for 1955, Plant "A" at Full-Plant Operation

Month	Raw Sewage, mgd.	Percent Return Sludge	Air, cu. ft./gal.	B. O. D., ppm.			Suspended Solids, ppm.					Sludge Index	D.O., Final Effl., ppm.
				Raw Sewage	Final Effluent	Reduction, %	Raw Sewage	Final Effluent	Reduction, %	Return Sludge	Mixed Liquor		
Jan.	6.323	45.5	1.72	330	21.5	93.2	238	18.6	92.1	7072	2321	122	0.8
Feb.	8.686	33.4	1.36	280	20.7	92.5	226	18.6	91.7	7284	1698	113	0.6
Mar.	8.257	35.0	1.40	267	16.5	93.8	235	16.9	92.7	8018	1894	144	0.9
Apr.	7.805	36.9	1.40	289	16.8	94.2	234	16.9	92.8	8924	1960	125	0.4
May	7.627	38.7	1.66	300	21.3	92.9	221	18.2	91.7	7266	1698	98	0.2
June	7.667	37.7	1.24	302	18.4	93.7	224	15.0	93.0	7149	1563	139	0.4
July	7.558	39.2	1.61	331	18.8	94.3	225	15.2	92.8	6050	1377	113	0.8
Aug.	9.093	33.0	1.46	297	19.4	93.4	218	19.0	91.2	5723	1692	145	.06
Sep.	8.632	39.0	1.63	299	17.6	94.1	216	17.2	92.2	6084	1829	114	0.9
Oct.	7.224	49.8	1.85	301	21.4	92.8	212	18.8	91.0	5223	1836	104	1.1
Nov.	6.655	54.5	2.02	354	22.9	93.4	232	18.3	92.2	6930	2432	85	1.0
Dec.	6.829	53.3	1.74	338	25.3	92.3	234	19.2	91.9	6903	2458	81	0.8
Avg.	7.696	41.33	1.59	307	20.0	93.4	226	17.6	92.1	6885	1896	115	0.7

Note: Since the total raw sewage flow now received at the plant is not sufficient to load both plant units "A" and "B", plant unit "A" is being operated more nearly at its design capacity while plant unit "B" is being operated on an idling basis. Results obtained from plant unit "A" are, therefore, considered more representative than from plant unit "B". For example, during January 1956 the total average flow was only 9.912 mgd., of which an average of 6.512 mgd. was treated in unit "A" and an average of only 3.400 mgd. was treated in unit "B".

activated sludge plants the air requirement is from 0.0038 to 0.0054 cu ft per gal for every ppm B.O.D. removed (approximately 0.5 cu ft of air per gal per 100 ppm B.O.D.). Approximately the same relation exists in "Biosorption" plant operation. Thus, when the raw sewage B.O.D.'s averaged between 200 and 250 ppm the air requirement was 1.0 cu ft or less per gal. More recently, since the raw sewage B.O.D.'s have averaged between 300 and 400 ppm., the air requirement has increased to 1.5 to 2.0 cu ft per gal.

In this connection it should be stressed that since, in the "Biosorption" plant, more than twice as much sewage or waste is treated in a given aeration tank capacity than was formerly treated by the conventional method, at least twice the volume of air must be supplied per linear foot (or per volume) of aeration tank. Thus, using the Austin plant as an example, with the conventional method up to 6,000 cfm. of air were used in two 1,000,000-gallon aeration tanks to treat approximately 6.0 mgd. of sewage having an average B.O.D. of 225 ppm, while in the "Biosorption" plant 6,000 cfm. of air must be supplied to one 1,000,000-gallon aeration tank to treat an equivalent volume of sewage having an equivalent B.O.D.

Also of interest is the fact that approximately the same amount of air has been used per linear foot of aeration tank in the mixing zone as in the sludge stabilization zone. Thus, about 80 percent of the air requirement has been used for sludge stabilization and about 20 percent for mixing. No studies have been made of this relationship and it is possible that the air efficiency could be increased by changing the relationship.

12. "Biosorption" plants use the same type of equipment as is used in conventional activated sludge plants. Therefore, the maintenance problems are essentially the same.

Design Data

As is true of all types of sewage treatment plants, the final design of a "Biosorption" plant should consider the character of the sewage to be treated. When the conversion of the Austin plant was planned the raw sewage B.O.D. averaged between 200 and 250 ppm and the maximum flow rate was about twice the average. The conversion was planned on the basis of the following design criteria, where Q = average sewage flow, S = return sludge rate, and A = air requirement:

1. Mixing time (Q + S) : Variable from 20 to 35 minutes, based on Q.

2. Clarifier (Q + S) : Retention time about 2 hours, based on Q. Overflow rate 700 to 900 gal per sq ft per day.

3. Sludge stabilization-oxidation tank: Retention time 2.5 hours, based on Q.

4. Air requirement: 1.0 cu ft of air per gal of Q, plus standby blowers. (A more realistic criterion would probably be 0.5 cu ft of air per gallon per 100 ppm B.O.D. to be removed, plus standby blowers.)

5. Return sludge rate: Maximum = Q (this can probably be reduced to 0.6 Q plus standby for return sludge pumping capacity).

6. Excess sludge disposal: Any of the methods commonly used for excess activated sludge disposal.

Conclusions

Austin's experience with the "Biosorption" plant has been good. It has been found to have the following advantages over the conventional activated sludge process in treating Austin's sewage:

1. It is less tempermental. Fewer adjustments are required for a wide range in sewage flows and loads.

2. Shock loads do not upset the plant as readily and slugs of toxic wastes are not as critical.

3. It has eliminated sludge bulking and frothing has been controlled. Frothing of the greasy type has been experienced, but has been a serious problem only when toxic wastes have been received, even though the raw sewage grease content appears to be high.

4. It requires less than one-half of the aeration tank capacity required for conventional activated sludge. This has made possible a substantial saving in capital outlay during the recent plant expansion.

Reference

1. Freese, S.W., "Aeration Tanks for Activated Sludge Plants." Proceedings, A.M. Soc. C.E. 63, 8(1937)

Federation Report — Part 2

Concluding installment of FSIWA 29th annual meeting in Los Angeles.

IN THE PREVIOUS ISSUE, *Water & Sewage Works* reported the first installment of the story of the 29th annual meeting of the Federation of Sewage and Industrial Wastes Assns. In addition to reporting convention business, honors, awards, inspection trips, etc., the previous issue reviewed four sessions covering six technical papers and a symposium on water pollution control. This part of the report covers the remaining papers and the three forums; sewer maintenance, industrial wastes and operators problems.

— Sewage Treatment —

R. F. Merz | W. W. Towne | G. L. Morris | A. H. Ullrich

Primary Lagoons

The INVESTIGATION OF PRIMARY LAGOON TREATMENT AT MOJAVE, CALIF. was the title of the paper presented by Robt. Merz, Prof of Civ. Eng., Univ. of So. Calif., Los Angeles.

He was introduced by presiding officer Emil Jensen. The research contract under which the study was made, called for the investigation of the possibility of waste water utilization. The lagoons studied were four feet deep and handled B.O.D. loads of 800 pounds per acre per day. It was the hope that the lagoon treated wastes could be used to irrigate grass at the Marine Air Base. Odors from the lagoons were slight and resembled those accompanying sewage when no sulfide odors are present. Evaporation and seepage from the lagoons amounted to twenty feet per year.

There were no mosquito problems and it was not difficult to control the growth of vegetation. It would appear that basins designed similar to those at the Marine base should provide average removals of B.O.D. of 60 per cent and soluble B.O.D. removals of 85 per cent under continuous loadings of upwards of 100 pounds of B.O.D. per acre per day. A depth of nine feet makes it possible to have influent mixing and diffusion and a detention time of less than one month with the rates of percolation and evaporation experienced, losses less than 20 per cent can be expected, thus making this system particularly suitable for waste water reclamation.

The paper was discussed by W. W. TOWNE of the U. S. Public Health Service. Towne said that with 42 lagoons in North Dakota, 32 in South Dakota, and several in other states, raw sewage lagoons have proven to be a practical minimum cost method of raw sewage treatment in the Northern Plains region. He said that even while in the trial and error stage of design they have increased in popularity at a phenomenal rate. At the present time the U. S. Public Health Service is working with the State of Texas in evaluating and analyzing the design and operating data on some 200 oxidation ponds in that state. In the Dakota studies, reductions in coliform density (MPN) were 99 per cent during more than 50 per cent of the time, and except for one sampling period at two installations, the removals were greater than 95 per cent at all times.

G. F. LAMBETH of the Dorr-Oliver Co. gave a paper on HIGH PURITY OXYGEN IN BIOLOGICAL TREATMENT. A pilot plant with a 50 to 75 gallon per minute flow has been built and operated on Stamford, Conn. sewage. The principle is the same as has been discussed by Fair, Malcolm Pirnie and Okun. In the pilot plant the activated sludge solids are maintained in one tank where pure oxygen is applied and mild agitation supplied with a mechanical mixing device and the sewage flows up through the sludge. In such an operation the active sludge is never away from the oxygen. The results indicate a 30 per cent saving in plant tank volume and a 50 per cent saving in plant area. The optimum loading seems to be 0.2 to 0.25 pounds of B.O.D. removed for each pound of activated sludge in the system. The success of the process will depend upon the economic handling and cost of the oxygen and whether the sludge volume can be controlled. Prof. D.A. Okun, of the Univ. of No. Car., Chapel Hill, N. C., discussed the paper and said he did not believe that oxygen accelerated bacterial oxidations. In his opinion, it must be learned whether oxygen is better than air.

Oklahoma City's Plants

OPERATION OF OKLAHOMA CITY'S SEWAGE PLANTS was reviewed by Grover Morris, Supt., who discussed some of the 15 plants that serve the city. The two major plants—the north side and the south side—were described. The south side works is a trickling filter plant that treats mostly domestic sewage and gets a highly nitrified effluent. The north side plant handles a considerable amount of industrial waste. The industries do largely meat packing and provide pretreatment with shallow settling tanks and grease skimmers. There is no difficulty with algae in the stream receiving the highly nitrified trickling filter effluent because of the high salt content in the receiving stream. It is sometimes necessary to take out a primary settling tank and one trickling filter in order to speed up flow so as to prevent odors.

Cannery Wastes

William J. O'Connell, Jr. Cons. Engr., Burlingame, Calif. presented a summary of CALIFORNIA FRUIT AND VEGETABLE CANNERY WASTE DISPOSAL PRACTICE. He said that he sees no substantial increase in fruit and

vegetable canning in California and that a majority of the canneries are located within cities or adjacent to their boundaries. He mentioned that flame peeling of some fruit and vegetables decreases the amount of waste that has to be disposed of. Instead of describing waste loads in terms of cases of cans, he uses a term "green ton equivalents". This is obtained by taking the total B.O.D. pounds for a total tonnage of all products and dividing it by the total tonnage of all products. The result is B.O.D. requirement for average green ton. Then the green ton equivalents are the pounds of B.O.D. per ton of product in question divided by the B.O.D. requirement per average green ton.

Dairy Wastes

DISPOSAL OF DAIRY WASTES BY SPRAY IRRIGATION was reviewed by Frank J. McKee, San. Engr., Kraft Foods Co., Chicago. He stated that there is a tendency towards a decrease in the number of milk processing plants and an increase in the quantity of milk processed in the remaining plants. In most cases for dairy wastes, the cost of construction of trickling filter and activated sludge treatment plants is prohibitively high and because of the high cost, spray irrigation is attractive. It has been found that spray irrigation can be used in northern climates on a year round basis. In some places, whey has been sprayed on land but in such instances it is impossible to grow vegetation. In most instances it has been found advantageous to raise a crop and that Reed's Canary Grass is one of the most sucessful crops. At Shirley, Ind., 10,000 gallons of wastes are sprayed on six acres each day. The spraying of wastes can be successfully accomplished with 80S Rainbird sprinkler heads. About 2500 gallons per acre per day seem to be an average application rate.

Tobe Arvolo presented a paper coauthored by Vinton Bacon on the LOCATION OF WOOD PRODUCTS INDUSTRIES TO BEST USE OF AVAILABLE WATERS. This paper outlined the program whereby certain industries can be encouraged to locate where there are known raw products, ample water for processing and where wastes can be discharged without serious difficulty with a minimum of waste treatment. This is a novel plan because it seems to incorporate the activities of a state chamber of commerce, water resources board, and stream pollution control agency.

"Biosorption" Modification of Activated Sludge Process

OPERATING EXPERIENCE AT AUSTIN, TEXAS WITH THE ACTIVATED SLUDGE AND "BIOSORPTION" PROCESS by Albert H. Ullrich, Supt, Water and Sewage Treatment, and Mansel Smith, Supt. Sewage Treatment Plant, Austin, Texas.

This paper, presented by Mr. Ullrich, related poor experiences with the straight activated sludge process on the strong and stale sewage of Austin, Texas. Numerous corrective measures proved inadequate, and by 1946 activation was discontinued, and plain aeration was resorted to, as the more effective method. Preaeration of supernatant liquor alone, and its return to aeration tanks did effect a higher plant efficiency but all other measures tried proved fruitless.

Something had to be done, so an experimental pilot plant was put into operation. The end result proved to be a drastic modification of the activated sludge process which has been named "Biosorption", based on the fact that major aeration is applied to the returned sludge. When mixed with settled sewage, the revivified sludge removes B.O.D. principally by absorption in a short mixed liquor aeration stage. Wet burning of absorbed organics and conditioning of the recirculated sludge is accomplished in long period sludge reaeration. The period of aeration of the mixture of revivified (or stabilized) sludge and settled sewage is on the average not more than 30 minutes, as against the 8 hour plant design period. The settling period of the aeration tank discharge of sludge-sewage mixture is 2½ hours. From the final settling tanks the returned sludge is rapidly withdrawn in a thin condition (5000 to 6000 ppm suspended solids) and in amount of 35 per cent by volume of the sewage flow. It is given the reconditioning (stabilization) aeration for a 6 hour period, enroute to the inlet end of the 30 minute aeration tank receiving the settled sewage and reaerated sludge mixture.

Mr. Ullrich explained that the return of the thin sludge produced the least foaming and the most effective overall plant performance. The long experienced sludge bulking has disappeared, although the effluent does contain a small amount of fluffy sludge particles. Shock loads are absorbed with little disturbance, and plant upsets are quickly rectified through sludge return control. The net result is a plant with designed aerator capacity of 6 mgd, with the consignment of one aeration unit to sludge reaeration and addition of a final clarifier, is now seemingly good for 16 mgd.

In brief, the modified process permits of lower cost plants than does the orthodox activated sludge process, the same being true of operating costs where strong sewage is involved.

— Industrial Wastes —

W. J. O'Connell F. J. McKee T. Arvolo

Combined Sewage—Industrial Waste Treatment

A COMBINATION INDUSTRIAL WASTE—SEWAGE TREATMENT PLANT was the title of the paper by Marvin Ray, Director of Public Works, Modesto, Calif. Mr. Ray had a most interesting story of a city undertaking to treat domestic sewage with a population equivalent of 18,000 in winter, and a population equivalent of 450,000 during the summer season when canning plant discharged wastes to the city sewers. First, 21 acres of oxidation ponds were used and a Dorrco "Vacuuator" of 50 ft diameter was added. Later a "Biofilter" of 200 ft diameter handling 30,000 gpm was constructed, also a so-called "deck aerator" designed by Modesto's consulting engineer. Then, what is thought to be the largest known experimental pilot plant was

Ed. Note: Experience in some detail with Austin's "Biosorption" process is the subject of a separate article by Mr. Ullrich, appearing in this issue.

jointly financed by equipment manufacturers, H. N. Jenks, the city's consulting engineer, and the city which contributed $12,000 to the cost. To be determined is the ultimate treatment, and design of a 30 mgd plant for treating an industrial waste load of 66 per cent by volume but 96 per cent in terms of B.O.D. loading.

Mr. Ray told of "Biofilter" loadings of 200 lb of B.O.D. per day, per acre foot, during canning season with satisfactory performance. Also, the use of 4,000 lb of chlorine per day for odor control. Also, the use of enzymes in 1953-'54 and '55, applied to the canning wastes, with good results.

Mr. Ray also revealed that Modesto would be required to so treat its wastes, as to maintain not less than 5 ppm dissolved oxygen in the stream below its sewer outfall during salmon runs. The pilot plant was expected to reveal the most economical method of providing the effluent quality to meet such requirements.

In answer to a question as to the proportioning of costs of the plant, and operating costs between industry, contributing 96 per cent of the loading and the city contributing but 4 per cent of the population equivalent loading, Mr. Ray said that the canning plants will pay 1/3 of the costs. A sewer service charge is made for domestic service. Mr. Ray did not explain the grounds on which Modesto is financing industrial waste treatment on such a seemingly inadequate participation by industry—33 per cent for 96 per cent population equivalent plant loading.

Hyperion Plant Studies

Los Angeles not only served as host city for the convention, but its famed and controversial Hyperion sewage plant also served as the basis for three technical papers and one discussion. The first paper and its discussion was part of the Monday afternoon session, the other two papers were presented at the Tuesday morning session.

Robert O. Bargman discussed the EVALUATION OF PREAERATION, AERATION AND SEDIMENTATION PROCESS AT HYPERION TREATMENT PLANT. Mr. Bargman is Asst. Chief Engr. of the plant. Frothing is one of the problems and it costs 17 cents per million gallons to control it with sprays. Oxidation reduction potential is used to determine the amount of aeration needed to keep the sewage from becoming septic. The amount of air required is believed to be in relation to certain characteristics of the sewage. The sewage that reaches the Hyperion plant has a much higher oxygen demand than the same sewage at some distance from the plant. He pointed out that the high rate process of treatment with aeration is usable and that B.O.D. and suspended solids removals of 70 to 85 per cent can be obtained. There does appear to be some instability of the process. The grease problem at the Hyperion plant has increased in magnitude in recent times.

Jack W. Pratt, Sales Engr., Process Engrs., San Mateo, Calif., discussed Mr. Bargman's paper and stressed the use of oxygen reduction potentials as a guide in the aeration processes. He believes that pre-aeration will improve the treatability of sewage by increasing the oxygen reduction potential.

J. W. Pratt

R. E. Stevenson

R. J. Theroux

—— Hyperion Plant ——

OCEANOGRAPHY STUDIES AT HYPERION OUTFALL were reported by R. E. Stevenson, Research Director, Univ. of Southern Calif., Los Angeles. Dr. Stevenson told of the drift card studies made of currents from the existing and proposed Hyperion sewer outfalls. He told of radio-activity added to Hyperion effluent which permitted a comparison between travel of the effluent toward the beaches and the coliform index. The studies were made to confirm the assumption that effluent distribution 200 ft below surface 5 miles offshore will not reach the beaches along the semi-circular bay. These studies also revealed the effectiveness of chlorination of the Hyperion Plant effluent in preventing coliform bacteria reaching the beaches.

PROPOSED ALTERATIONS TO THE HYPERION ACTIVATED SLUDGE PLANT AND OCEAN OUTFALL were discussed by Robert J. Theroux, Project Engr., Hyperion Engineers, Los Angeles.

Mr. Theroux reported that Los Angeles is to spend an additional $60,000,000 for additional facilities for collection, treatment and disposal of its sewage. The existing Hyperion Treatment Plant will be operated as a conventional activated sludge plant, capable to treating 120 mgd. Enlargement of the plant will provide plain sedimentation for an additional 300 mgd. The combined effluents will be discharged to sea through a 5 mile long 12 ft outfall terminating with a diffusing system 194 ft under water. Digested sludge will be pumped to sea 7 miles off shore through a 22 in. steel pipe outfall terminating 300 ft below surface. Production of fertilizer will be discontinued. Plant effluent as well as digested sludge will require pumping through the long outfalls.

Hapman Tubular Grit Conveyors are to be installed in the existing pre-aeration tanks beneath the Chicago Swing Diffuser Tubes. New grit removal facilities will employ air washing, and Hapman Conveyors for collection, and transport to elevated hoppers for removal by truck.

Pre-aeration of Los Angeles sewage has created odor nuisance and hydrogen sulphide attack. There has been no noticeable benefit to primary settling or the activated process and will not be incorporated in the plant additions.

As an odor control measure, ventilation air will be taken into the air compressors supplying air to the activated sludge process.

A major feature of the expanded plant will be the two pumping stations for plant effluent and sludge. Continous pumping of sludge is proposed. The sludge will be diluted to the desired solids content. The diluting effluent will be pumped in the sludge line alone if sludge is not available continuously. The main effluent will require pumping only when exceeding a 300 mgd rate through the plant. Provision has been made for running cleaning mechanisms through the effluent and the sludge outfalls. The cement lined and tar coated gunnite exterior steel sludge line will also be provided with cathodic protection.

Studies are now under way looking to the practicability of ground water recharge with effluent from the activated sludge plant to the maximum extent possible. Failing in ground water recharge effluent may be piped to industry. It is proposed to find a

power generating customer for the surplus digester gas which is to be appreciable. The Dept. of Water & Power is a likely buyer for a proposed nearby power plant.

Sewer Maintenance Forum

Under leadership of Orville L. Dickinson, Engineer, Clay Products Institute, Los Angeles, the following members participated in a panel discussion, key-noted by Dr. Richard Pomeroy, Consulting Chemical Engr., Pasadena, Calif.

M. B. Nixon, Engr. of Sewers, Atlanta, Ga.; Grant M. Olewiler, Supt. San. Dist., Ardmore, Pa.; John D. Parkhurst, Res. Engr., L.A. County San. Districts; Sydney Preen, Supt. Sewer Maint., Long Beach, Calif.

WHY MAINTAIN SEWERS?, the question that opened the session, was ably discussed by DR. POMEROY who emphasized effective sewer cleaning to maintain capacities; to avoid odor nuisance, and sewer attack due to hydrogen sulfide generation; to preclude liability suits due to laxity in sewer cleaning and effective maintenance. He pointed out that the increasing use of household garbage grinders had made systematic sewer cleaning more important than heretofore.

As to costs of maintenance, $125.00 per year per mile seemed to be an average figure. Of this $90.00 per year per mile represented cost of cleaning at Long Beach, Calif., where 75 per cent of all sewers are cleaned yearly at a cost of 0.33 per cent of the cost of the sewers. Cleaning operations and equipment used at Long Beach were shown in a splendid color film—especially the effective use of the Wayne Sewer Cleaning Balls developed by "Syd" Preen, Supt. of Maintenance at Long Beach. The movie pictured the high velocity swirling of the spiral-finned heavy duty rubber balls on the end of a small feed out cable. The film also showed the very expertly designed and completely equipped sewer maintenance truck of Long Beach. (Watch for a description of this maintenance truck in a future issue of *Water & Sewage Works.*)

Dr. Pomeroy told of the use of neoprene gaskets to stop objectionable manhole lid bang and also stressed the fact that, with present day equipment and an effective sewer cleaning program, greater economy in sewer design is permissive; i.e. less slope of sewers, less pumping, etc.

MR. PARKHURST, of L.A. County, said that sewer maintenance men seemed to be a "breed of their own". As to maintenance costs, in the smaller community it might run up to $400 per mile per year. He stressed the importance of ventilation of every manhole before letting men go down. This is done by operating a suction fan at the next lower manhole. He pointed out that a hard grease ring in a sewer can not be removed by use of rubber cleaning balls. A cutting tool is needed for this job.

In subsequent discussion, it was stated that the head required to propel the cleaning balls is 12 inches or more, the greater the head the faster the operation. The greatest hazard of head build up is possible basement flooding.

MR. PREEN, of Long Beach, Calif., said that a ball should never run tight through a sewer but should have room for gyrating swirl and under scour. At Long Beach cleaning costs of $90 to $93 per year per mile had included insurance and every other cost.

MR. OLEWILER, of Ardmore, Pa., felt that flushing between cleanings on the Merion Township system had been very helpful. Hydrant flushing is not nearly as effective as tank truck flushing. The tank truck of 700 gal capacity has three compartments with quick empting valves to drop a slug of scouring flush water. They use a four man maintenance crew. Instead of cleaning balls, a "Flexible" chuck is used to good effect.

MR. NIXON, of Atlanta, Ga., stated that a survey revealed that maintenance cost per year per mile had averaged in excess of $200 for a number of cities.

EFFECTS OF GARBAGE GRINDERS ON SEWERS was reported by Kenneth Scharman, Mgr., Pima County Sanitation Distr., Tucson, Ariz.

Finding two sewers of practically identical grade (0.72 per cent) and length (800 ft) and same number of homes connected, the effects of home garbage grinders could be studied conclusively for nine months. The sewage flow averaged 50 gal per capita. The principal difference in the sewage carrying the ground garbage was a slightly higher hydrogen sulfide content; a lower pH value by 1.8 points, a higher temperature (90°); 336 ppm greater suspended solids; a practically doubled B.O.D., the increase being 248 ppm as the nine month average. The most objectionable components had been the easily stranded egg shells and the grease ring deposited on the pipe walls. Experience indicates, however, that cleaning with the rubber balls will remove the grease and shell accumulations.

PHOTOGRAPHIC INTERIOR SEWER INSPECTIONS was an interesting presentation by Alvin A. Appel, Supt., Sewer Maintenance Div., Dept. of Public Works, Los Angeles, Calif.

Mr. Appel who has served the L.A. Dept. of Public Works for 33 years related the value of photographic records of the interior condition of sewers. The hazards of man made photographic records, contributing to the death of an earlier superintendent, had led to the development of lighting and camera equipment sent through sewers on specially designed miniature boats without manual attention. The boat as finally perfected is constructed of stainless steel and fiber glass. The special fog piercing spot-light operates from dry cells as does the camera operation. Color photographs on the screen revealed points of gas attack of the sewer, spalling of terracotta liner plates, bad joints, infiltration, etc. One particularly bad condition was revealed in the vicinity of a force main discharge into the gravity sewer, releasing hydrogen sulfide gas to create pronounced sewer wall attack. Another attack spot was noted where debris

—— Sewer Maintenance Forum ——

O. L. Dickinson R. Pomeroy M. B. Nixon G. M. Olewiler A. A. Appel

created turbulence to release the destructive sulfide gas. Recently, these photographic surveys have been contracted for with the Los Angeles firm, Rodding & Cleaning Co., which perfected the boats, camera and lighting arrangements.

Operator's Forum

The final half day was devoted to two parallel "Forums"—one on "Industrial Wastes" and the other to plant operating problems. Lee Kraus, Supt. of the Peoria, Ill. plant presided at the "Operator's Forum" and Wm. F. Garber, Lab. Director, Hyperion Treatment Plant, Los Angeles, served as leader of the Forum.

The session was opened by Bernard B. Berger, Chief, Water Supply and Pollution Control Research, U. S. PHS Cincinnati, Ohio. Mr. Berger spoke on U. S. PUBLIC HEALTH SERVICE PROGRAMS OF INTEREST TO SEWAGE WORKS OPERATORS and related a number of studies being made at the Robert A. Taft Sanitary Engineering Research Center of the Public Health Service. Among these are revised standards for raw water quality of a more realistic nature; a careful study of the Micro-Filter Technique for bacterial tests on waters; a possible better yard-stick than the coliform test; a continuous D.O. recorder for streams and effluents; bio-oxidation processes; industrial waste treatment; oxidation ponds for sewages and wastes; water conservation through recovery from sewage and wastes.

Mr. Berger also referred to the Advance Training Courses for Chemists and Engineers of 1 to 2 weeks which were given at the Taft Center, and a proposed digest of papers from the Center for distribution. During 1955 and 1956, no less than 800 engineers and chemists attended the Advanced Training Courses, indicating an apparent need.

MAINTENANCE OF SEWAGE WORKS INSTRUMENTS was discussed by Jack M. Betz, Engineer, Hyperion Treatment Plant, Los Angeles, Calif.

Mr. Betz, after pointing out the worth of good plant instrumentation, felt that design engineers were less familiar with instrumentation than should be the case. For the smaller plants, however, instrumentation should be held to a practical minimum because of the need for good maintenance by qualified men. He did not believe that instruments in the development stage should be tried in sewage plants for reasons best understood by operators.

In comparing pneumatic with electrical transmission between the primary element and instruments Mr. Betz said the pneumatic system up to the 500 ft limit had been more satisfactory. A clean and dry air supply is a "must" however. At flow transmitters, an indicating scale is an important adjunct. Venturi-meters in sewage plants should have a removable throat section. For sludge, a Venturi tube should have no piezometer ring. Purge lines to the meter should be no smaller than ¼ inch and transmit 0.2 to 0.3 gpm of flushing water. These lines should be equipped with check valves and air vents at high points. Instruments should be checked with purge line flow on and off. Continuous slope to purge lines is important.

—— Operator's Forum ——

L. S. Kraus W. F. Garber C. J. Geraghty E. P. Coleman

For sewage plants, a 2 per cent instrument accuracy is very good and even 3 to 5 per cent may be acceptable. For small plants, only the simplest instrumentation can be justified. Venturi tubes on raw sewage should be cleaned yearly and a removable throat section is advocated to facilitate such cleaning. The small plant superintendent might explore the possibility of contracting for periodic instrument service as the most practical maintenance procedure. Where there is a capable man on the staff, he might be sent to one or more of the Instrument Maintenance Training Schools conducted by manufacturers.

A NEW PROCESSING TECHNIQUE IN SLUDGE DISPOSAL was described by C. J. Geraghty, San. Engr., Redwood City, Calif. Mr. Geraghty described a process developed by himself for profitable sludge disposal which consists of spreading digested sludge 3 to 6 in. deep on a bed of a cellulostic material and allowing it to dry to 60 per cent moisture, then respread over and over to a 15 in. depth and allow to dry to 30 per cent moisture. The disposal of 700 tons per year on one acre of area is readily achieved—i.e., 0.5 sq ft per capita. The advantages of the process are that no underdrained beds are required, and a simple turnover (tilling) replaces tedious sand bed scraping. The cost of the finished material is but 65 cents a cu yd, 50 cents of which is for peat moss used as the absorbent of ammonia rich sludge liquor. At the cost of $1.54 per ton of finished product, which can be used directly on plants or crops, or sold in bulk to fertilizer producers, there is money to be made. The product is both moisture retaining and a gradual releaser of nitrogen.

THE ENGINEER AS MANAGER was discussed by E. P. Coleman, Univ. of California, Los Angeles. Prof. Coleman said that lack of effective communications is responsible for indifferent to poor plant management. Among management rules, he said that the good manager considers how he would respond, if in the subordinate position and following the golden rule at all times. He recommended "The Underwritten Law of Engineering" by Julian King as worthy of study. This article appeared in the A.S.M.E. Journal for 1946.

Industrial Waste Forum

E. F. Eldridge, Dir. Ch. Engr., Washington State Pollution control Comm., Olympia, Wash. served as leads of the forum. The theme of the session was "pilot plants."

Pulp Mill

The Weyerhaeuser Timber Co. desired to build a pulp mill at Grays Harbor in an area where there were salmon, steelhead trout and oyster fishing of considerable economic importance, so it was necessary to give attention to a suitable location for the mill. This attention resulted in a PILOT STUDY TO PREDICT EFFECTS OF WASTES ON RECEIVING WATERS.

MR. P. BILLINGTON described the system of tanks used to simulate the various bays of the salt water harbor that would have to receive the waste from the pulp mill. In order to determine the relative volumes in the bays a topographic map of the area was obtained and the harbor area was cut out of wood and then divided

into sections that were weighed on an analytical balance and the volume of water obtained by getting the average depth of harbor in each cut out section. Salt and fresh waters were used to represent river and ocean water. The pollution in the model study was represented by ferrous aluminum sulfate. The data accumulated from the model testing when analyzed showed that by carrying the waste from the mill to an outfall three miles downstream that a seven-fold improvement in stream condition could be obtained. Still further help in maintaining suitable conditions was found to be possible if a holding lagoon were constructed and used so that wastes from the mill were discharged only during falling tide.

A PILOT STUDY ON THE PRODUCTION OF HIGH PROTEIN FEED FROM PULP WASTE was described by Herman Amberg of Central Research, Crown Zellerback Corp., Comos, Wash. The pulp waste is inoculated with aerobic bacteria that transform the dissolved solids of the waste into bacterial cells that are high in protein. The process is similar to the activated sludge process with the waste sludge being processed for animal feed.

Statistical Studies

James C. Lamb III, and H. Van Blarigan, San. Engrs., Amer. Cyanamid Co., Bound Brook, N. J. discussed STATISTICAL INTERPRETATION OF PILOT-PLANT STUDIES. They pointed out that if a statistical design is made prior to the taking of data for any particular study the minimum effort will be expended in getting significant information.. With the accumulated data an equation can be obtained by the use of an electrical computer that will show the proper relation of all components within the range of the data. This is a method of handling analytical data that will become more widely used as time goes on.

Background Study

Robert O. Sylvester, Asst. Prof. Civ. Engrs. Dept., Univ. of Wash., Seattle, impressed those in attendance of the VALUE OF BACKGROUND STUDY prior to the location of any new plant that will discharge any waste waters whatever. He said that any industry should take samples to determine the dissolved oxygen in a stream prior to the construction of the new plant. It was recommended that many pictures be taken as evidence of conditions that exist. Dredgings and identification of the species found is recommended. It was apparent from Professor Sylvester's remarks that considerable money can be well spent in getting background information.

— Industrial Waste Forum —

L. L. Hedepeth E. F. Eldridge P. Billington H. Amberg J. C. Lamb III R. O. Sylvester

Significant Changes in ASTM Concrete Pipe Specifications

An entirely new concept in the design and requirements of concrete pipe was presented to the Am. Soc. for Testing Materials Committee C-13 on Concrete Pipe at its recent meeting in Chicago.

A technical committee from the concrete pipe industry has accomplished a very comprehensive research program, coupled with engineering study. Based upon this substantial background of data, Committee C-13 carefully reviewed and accepted a proposed complete revision, of the specification for reinforced concrete pipe for gravity sewers and culverts. This involved revising, combining and enlarging the present requirements of specifications C75 and C76. The recommendation calls for the discontinuance of A.S.T.M. specification C75, and designation of the new specification as C76.

The new concept in design is known as the "D-Load" method, which is a means of classifying the load on pipe. There will be two kinds of D-Loads for the three-edge-bearing test. "D-Load Ultimate" is the load per lineal foot of pipe per foot of diameter to produce ultimate failures. "D-Load .01-inch crack" is the load per lineal foot of pipe per foot of diameter to produce the .01-inch crack. The new specification is designed for both types of D-loads, whichever is desired by the user. Tables make it possible to choose the pipe especially designed to withstand five different degrees of loadings.

Important changes were accepted for immediate adoption in the Specification for Concrete Sewer Pipe (C 14). A basic change provides two tables, one for standard strength, the other for extra strength, non-reinforced concrete sewer pipe. A new section was added to provide control requirements on the repair of pipe due to occasional imperfections in manufacture or accidental injury during handling. Changes were made in the section describing the permeability test to provide greater clarity and understanding.

The Tentative Specification for Reinforced Concrete Low-Head Pressure Pipe (C361-T) is to be revised. The changes accepted pertain to the sections on basis of acceptance, minimum design, longitudinal reinforcement, joints, curing, permissible variation in dimensions, and repair. No changes were recommended in the Tentative Specification for Reinforced Concrete Low-Head Internal Pressure Sewer Pipe (C362-T).

A special Subcommittee on Absorption presented revision, and smaller area of specimen, in specifications for reinforced concrete sewer and culvert pipe to provide for use of cores, and smaller area of specimen, in determining absorption.

A special subcommittee will develop requirements for rubber joint ring couplings for concrete pipe.

Black & Veatch Engineers Move to Larger Offices

Black & Veatch, consulting engineers of Kansas City, Mo., have announced the moving and consolidation of their offices. The former location was on the Country Club Plaza. The new and more spacious offices are at 1500 Meadow Lake Parkway, Kansas City 14, Missouri.

SEWAGE WORKS PRACTICES

Sludge Digestion

Series 2—Part 8

by DON E. BLOODGOOD

Mr. Bloodgood is Professor of Sanitary Engineering at Purdue University, Lafayette, Ind. In this series, he discusses SEWAGE WORKS PRACTICES in a manner designed to assist plant operators, students and others who wish to review the subject matter.

ALMOST EVERY sewage treatment plant in the world applies the process of anaerobic decomposition in the disposal of organic solids. Buswell[1] has written a summary about the use of fermentations in waste treatment. He states that there have been many points of controversy and that even when he wrote in 1954 they had not all been settled.

Methane Fermentation

The anaerobic decomposition of organic solids such as those found in sewage is sometimes called *methane fermentation* because the largest portion of the end product gases is methane. The other gas formed is mostly carbon dioxide. In many fermentations it is quite necessary to provide a pure culture of some microorganism in order to accomplish the desired end. This situation is not true in the methane fermentation of organic solids. In this process it is quite apparent that a mixed culture is at work in the anaerobic decomposition of sewage solids.

In fact, a mixed culture may be necessary in order to convert complex organic solids into methane. This statement is partially proven by observation of nature at work in those places where organics are allowed to accumulate and there is an absence of oxygen. It seems that almost spontaneously decomposition sets in. Not being believers in the miraculous, it must then be concluded that there must be methane-producing organisms widely scattered in nature.

There is considerable difficulty experienced when a bacteriologist attempts to isolate methane organisms so the study of them in pure culture has been limited. It is now believed that besides being methane producers these organisms are non-motile, nonspore forming and Gram negative. They have the ability to use ammonia as a source of nitrogen. It has been observed that they grow at a relatively slow rate, sometimes requiring several weeks to develop into an active culture. These organisms are not necessarily the ones that decompose the complex organic solids in sewage sludge.

Studies have been made to determine what takes place in the decomposition process when sewage solids are disintegrated and the reports indicate that volatile acids are first formed. Acetic, butyric, propionic and valeric acids have been isolated from digesting mixtures. It has been indicated by many writers that it is the decomposition of the volatile acids that results in the formation of the methane and carbon dioxide that make up the major portion of the gas from sludge digestion tanks. Teletzke and Rohlich[2] have reported on a method for determining the concentration of the various acids. They used a chromatographic method for separation and identification of the acids.

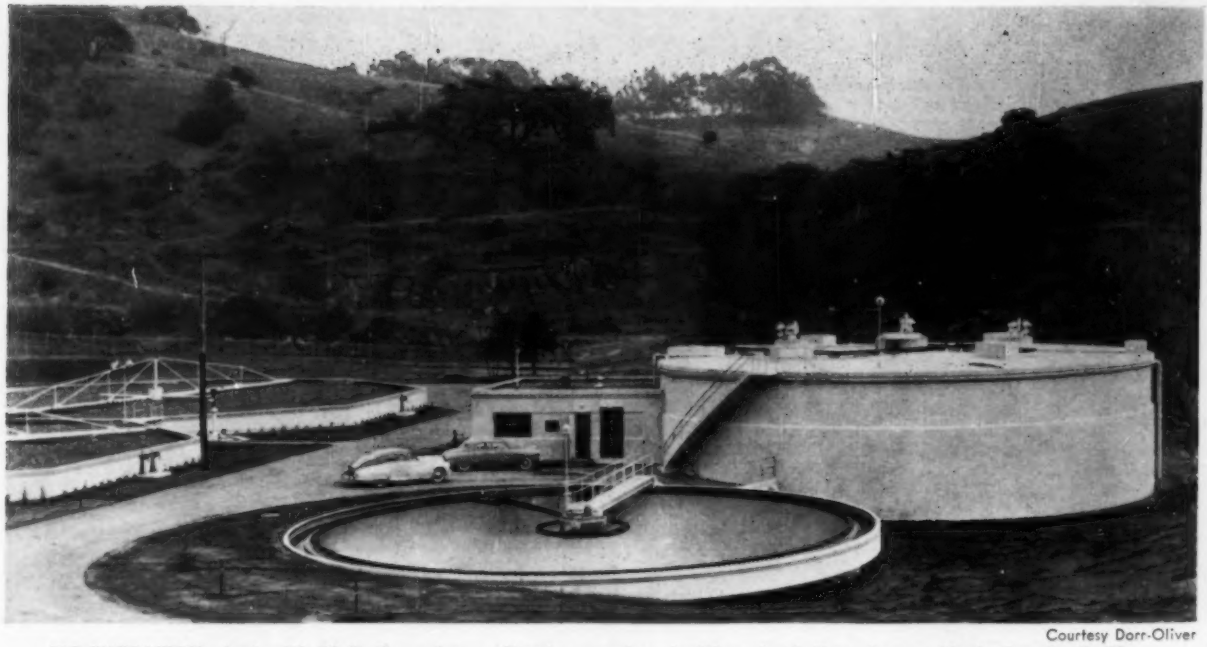
The ratio of carbon dioxide produced to the quantity of methane depends upon the elemental constituents of the compound being used by the bacteria as food. Symons and Buswell[3] stated that for compounds containing carbon, hydrogen and oxygen the general reaction in the methane fermentation can be predicted according to the Equation 1. C is carbon, H is hydrogen, O is oxygen and the subscript letters are for the number of atoms of the respective substances. Symons says, "If water, carbon dioxide, and methane are the only substances involved in the reaction besides the substrate, then their coefficients may be determined algebraically in terms of the numbers of atoms in the substrate molecule. The equation may also be developed in a stepwise manner, the first step being an oxidation-reduction by water to give carbon dioxide and hydrogen, and the second a combination of the hydrogen with part of the carbon dioxide to form methane and water.

This equation gives a simple method for writing the balanced reaction for that portion of the substance that is converted to methane and carbon dioxide. This equation not only defines the gas ratios but also the weight of the gases produced."

Symons and Buswell[3] also report a still more general equation that applies when more complex materials are decomposed. See Equation 2

$$C_nH_aO_b + \left(n - \frac{a}{4} - \frac{b}{2}\right) H_2O \rightarrow \left(\frac{n}{2} - \frac{a}{8} + \frac{b}{4}\right) CO_2 + \left(\frac{n}{2} + \frac{a}{8} - \frac{b}{4}\right) CH_4 \quad (1)$$

$$C_nH_aO_bN_cS_dM_{ev} + \left(n - \frac{a}{4} - \frac{b}{2} + \frac{7c}{4} + \frac{d}{2} + \frac{3ev}{4}\right) H_2O \rightarrow$$
$$\left(\frac{n}{2} - \frac{a}{8} + \frac{b}{4} - \frac{5c}{8} + \frac{d}{4} - \frac{9ev}{8}\right) CO_2 + \left(\frac{n}{2} + \frac{a}{8} - \frac{b}{4} - \frac{3c}{8} - \frac{d}{4} + \frac{ev}{8}\right) CH_4$$
$$+ cNH_4HCO_3 + dH_2S + eM(HCO_3)_v \quad (2)$$



Courtesy Dorr-Oliver

BIO-FILTRATION plant with 80-ft dia. primary digesters equipped with recirculating mixers.—Marin County, Calif.

where C is carbon, H is hydrogen, O is oxygen, N is nitrogen, S is sulphur, M is any metal ion, v the valence of M and a, b, c, d, and e, the number of atoms present.

Both of these equations show that there is a very definite relationship between the pounds of organic solids destroyed and the volume and weight of gas produced. The weight of gas produced is usually greater than the pounds of solids destroyed because some water is used in the process and therefore the hydrogen and oxygen from the water make up part of the methane and carbon dioxide.

Temperature

Digestion of sewage solids has been accomplished at different temperatures. It has been found by practical experience that digestion does not take place at temperatures around 39° F. It can be assumed that when solids are placed in a tank that is maintained at near that temperature it is much like preserving materials in a refrigerator. A tank used to store solids at low temperatures will, when warmed, attempt to digest all of the organic matter in a short period of time. The results are usually disastrous.

The work of Fair and Moore[4] gives some idea about the rates of digestion at different temperatures. Their experiments were conducted using Imhoff sludge collected at Fitchburg, Mass. and seeded with sludges that remained from previous tests at particular temperatures. The "time of digestion" was obtained by recording the number of days required to produce a quantity of gas equal to 90 per cent of the total produced at 59°F. The data collected by Fair and Moore is presented in Table 1. It seems very possible that the time of digestion at the different temperatures given by them, may be considerably higher than the time of digestion required in modern digestion tanks because modern tanks are fed continuously and a maximum number of active organisms is probably present at all times. In the studies reported there may have been a delay of several days before the organisms reached their maximum activity. The quantity of gas produced (90 per cent of the ultimate) was 7.65 cu ft per lb of fresh volatile solids added. The information given by Fair and Moore is, however, an excellent guide to those who need to know the effect of temperature on sludge digestion.

TABLE 1

Time Required to Digest Sludge at Various Temperatures (By Fair and Moore)[4]

Temperature °F.	Time of Digestion Days
59	67.8
68	46.6
77	37.5
86	33.3
95	23.7
104	22.7
113	14.4
122	8.9
140	12.6

Quality of Gas Produced and Per Cent Digestion

All of the solids added to a digestion tank are not decomposed, in fact, all of the volatile solids are not de-

TABLE 2

Volatile Solids in Raw and Digested Sludges

City	Type of Plant	% Volatile in Dry Sludge	
		Raw	Digested
Gary, Indiana[5]	Activated Sludge	52.4	46.0
Toledo, Ohio[6]	Primary	66.1	43.1
Jackson, Mich.[7]	Activated Sludge	58.0	42.0
Racine, Wis.[8]	Primary	57.4	38.2
Fort Wayne, Ind.[9]	Activated Sludge	56.0	40.0
Average		57.9	41.9

SLUDGE DIGESTION is established practice at Green Bay, Wis.

composed. It has been estimated that about half of the volatile solids are converted to gas in digestion. The average data from five midwestern cities, presented in Table 2 shows the volatile solids content in raw and digested sludge to be 57.9 per cent and 41.9 per cent.

These data indicate that in 2000 pounds of raw solids there are 1158 pounds of volatile solids (2000 x 0.579) and 842 pounds of ash (2000 −1158). In the digested sludge there are 842 pounds of ash that is 58.1 per cent of the digested sludge (100.0 per cent−41.9 per cent). The total solids in the digested sludge amount to 1449 pounds (842÷0.581). There are 607 pounds of volatile solids in the digested sludge (1449−842). Originally there were 1158 pounds of volatile solids in the raw sludge and after digestion there are only 607 pounds, which means that 551 pounds or 47.5 per cent would have been destroyed in digestion or (551 x 100÷1158), i.e., the per cent digestion is 47.5.

It has been pointed out that there is a relation between the pounds of volatile destroyed and the volume of gas produced. It would, therefore, seem advisable to have reported the quantity of gas produced per unit of volatile solids destroyed. Most of the reporting however, is on the basis of cubic feet of gas per pound of volatile solids added. The quantity of gas produced, by this more common way of reporting, is between 6 and 8 cubic feet per pound of volatile solids as shown in the data presented in Table 3.

TABLE 3
Gas Production from Volatile Solids

City	Cu Ft of Gas Per Lb Volatile Solids Added	Cu Ft of Gas Per Lb Volatile Solids Digested
Fort Wayne, Ind.[9]	7.2	15.1
Racine, Wis.[8]	5.8	10.7
Jackson, Mich.[7]	5.4	11.3
Richmond, Ind.[10]	7.6	—
Aurora, Ill.[11]	6.0	11.3
Average	6.4	12.1

GAS HOLDER at Sheboygan, Wis. plant

It appears that the quantity of volatile solids in a raw sludge may not necessarily indicate the amount of gas that can be produced from it but it is apparent that usually the amount of gas produced is in direct relation to the amount of volatile solids decomposed.

Heating of Digestion Tanks

To maintain a satisfactory temperature in a digestion tank it is necessary to supply heat to compensate for that lost through the walls and to raise the temperature of the raw sludge being fed, up to the temperature being maintained in the digestion tank. The amount of heat lost through the tank walls depends upon the degree of insulation of the tank and the difference between the temperature on the inside and outside of the tank.

Babbitt[12] says that the heat lost from a tank in a day can be calculated by the formula

$$H = 24A_t\ (T_i - T_e)\ (C_1)$$

Where

H = Btu lost from a tank per day.

A_t = surface area of the tank, top, bottom and sides in square feet.

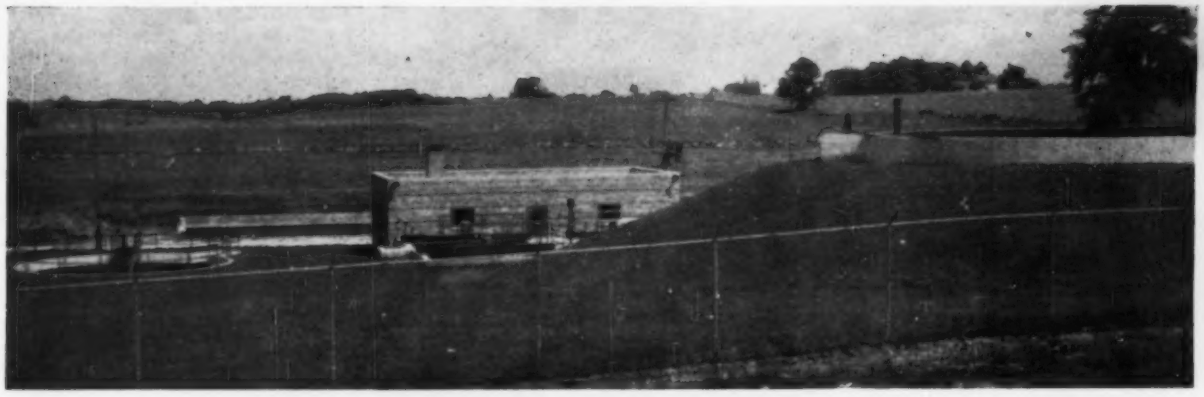
T_i = temperature, degrees Fahrenheit inside the tank.

T_e = temperature degrees Fahrenheit, outside the tank.

C_1 = coefficient of thermal conductivity in Btu per hour per square foot of tank surface per degree (Fahrenheit) difference in temperature.

The coefficient C_1 has been said to be 0.07 for concrete entirely covered with dry earth, 0.10 for a concrete with the top exposed to air and surrounded by dry earth, and 0.20 to 0.25 for a concrete tank with the top exposed to air, the sides covered with moist earth and the bottom in ground water.

A concrete tank 30 feet in diameter and 20 feet deep with earth banked to the top is perhaps representative of a small installation. Computations for the heat loss from this tank would be:



DIGESTER at right—New Holstein, Wis.

Area of top = $30^2 \times \pi \div 4 =$ 706 sq ft
Area of bottom = $30^2 \times \pi \div 4 =$ 706 sq ft
Area of sides = $30 \times \pi \times 20 =$ 1884 sq ft
Total area = 3296 sq ft
Operating temperature of tank = 90°F.
Outside temperature, mean for Mid-West = 52°F.
Coefficient of thermal conductivity = 0.10
$H = 24 \times 3296 \times 38 \times 0.10 = 300{,}595$ Btu

The heat value of sewage gas is 585[11] to 646[13] Btu per cu ft and the amount of gas required to keep the 30 ft diameter tank warm would be approximately

$$300{,}595 \div 646 = 465 \text{ cu ft.}$$

This digestion tank has a volume of 12,708 cu ft and when operated under an average loading of 3500 persons (3.62 cu ft per cap.) it might be expected to produce 2200 cu ft per day if the gas production is about average. (Average at Racine, Wis. for 1951-55 was 639 cu ft per cap. per day[8]). It takes about 21 per cent of the gas produced to keep the digestion tank up to temperature. On a cold winter day the gas required would be as much as 50 per cent of the total produced.

Babbitt[12] has also presented a formula for the calculation of the heat required to raise the temperature of the incoming sludge to that of the sludge in the digestion tank. The formula is:

$$H = W(T_t - T_s)(S)$$

In this formula H is the Btu required to raise the daily sludge addition to the temperature of the sludge in the digestion tank; W is the weight of sludge entering the tank; T_t is the temperature of sludge in the tank degrees Fahrenheit; T_s is the temperature of the sludge entering the tank in degrees Fahrenheit; S is the specific heat of sludge which is taken to be equal to 1.0 but actually may be slightly less than this number.

With a sewage flow of 100 gal per capita, 200 ppm of suspended solids and a 50 per cent removal in primary treatment there should be 5820 pounds of sludge with 5 per cent solids concentration produced. The heat required to raise the temperature of this 60°F. sludge to 90°F. would be

$$H = 5820 \ (90\text{-}60) \times (1) = 174{,}600 \text{ Btu}$$

To supply this number of Btu would take 270 cu ft of gas.

If supernatant is withdrawn heat is removed from the tank and this is also a loss in heat from the tank. This quantity of heat is also 174,600 Btu because this is the amount of heat required to raise an equal weight of sludge entering the tank.

According to these calculations, it would require 1005 cubic feet of gas per day to heat the incoming sludge, to make up for the heat lost through the walls of the tank, and to account for the heat removed from the tank in the supernatant.

This illustration shows that about 45.5 per cent of the gas produced is required to maintain the temperature in a digestion tank of this size. If the temperature in a digestion tank cannot be maintained with the gas being produced an operator can determine the volume of gas that can reasonably be expected by use of the formula.

$$G = 5.3312 \text{ VAB}$$

where

G = cubic feet gas per day
V = volume of sludge in gallons
A = solids concentration of sludge (%)
B = Vol. solids, % of dry solids

$$5.3312 = \frac{8.34 \times 6.4}{100 \times 100}$$

× cu ft/lb vol. solids added

Summary

1. Methane forming bacteria are known to multiply at a slow rate.
2. Acetic, butyric, propionic and valeric acids are formed in digesting sludge.
3. The ratio of methane to carbon dioxide in sewage gas depends upon the organic constituents of the sludge being digested.
4. There is a definite relation between the amount of solids decomposed and the quantity of gas produced.
5. Temperature of the liquid in a digestion tank controls the rate of decomposition of the sludge.
6. About 50 per cent of the organic matter in raw sludge is converted to gas in sludge digestion.
7. All of the volatile solids in sewage sludge are not decomposed.
8. An adequately fed digestion tank should produce a sufficient amount of gas that when burned should maintain the temperature of the digestion tank above 85°F.

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How to
Collect, Store and Use Data

By employing various tools, is the theme of this article

by JAMES M. SYMONS and GEORGE E. SYMONS
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THE OPERATION of water treatment, sewage disposal, garbage incineration, and industrial waste plants involves the collections, storage, and use of numerical data. Data must be recorded. Attempts to correctly remember masses of data will lead only to error. To be of any value in operation, data must be compiled in a manner which is useful for operational control.

Data must be collected to meet legal requirements or to satisfy the directives of municipal officials but of what real value are piles of dusty books containing records of years ago? It is not suggested that every piece of data collected must be put to daily use in order to be worth collecting. It is suggested, however, that much of the data collected could be used to help an operator with his daily work, whereas it is merely filled "for future reference" because the operator is not always familiar with all of the mathematical tools available to arrange the data in useful form.

A Basic Question

As one approaches the subject of data utilization, specific questions may be asked such as: Of what use is a pie chart? How does a line graph differ from a bar graph? What is a nomograph? etc. Before answering such questions it is desirable to answer a more general, but fundamental question—how do I use data?

The first step in preparing data for use is to decide what information is of interest; for example: Pounds of alum to be added related to flow, turbidity of influent related to rainfall; on what is the maintenance dollar spent?; dissolved oxygen in the aeration tank related to hours of the day, and so forth. The second step is to collect the specific numerical data needed. Comparison of these data with the outline given below will show whether a table, chart, diagram, graph or nomograph will present the data in the most useful manner. Finally, the appropriate mathematical tool should be employed.

Tools Available

The purpose of this article is to examine five mathematical tools most useful to the operators of sanitary engineering facilities. The discussion of each will contain: Areas of applicability, methods of construction, and examples. The five tools to be examined are defined for the purpose of this article in the following manner:

1. Tables—A representation of data in condensed tabular or columnar form.

2. Charts—A pictorial representation of data or physical conditions.

3. Diagrams—A schematic representation of complex patterns of flow, either in the physical sense or as in chain of command.

4. Graphs—The representation of the inter-relationship of two or more items, one with the other.

5. Nomographs—An alignment chart consisting of three or more scales so arranged that a straight line between any two points on two scales will cut the third scale at a point bearing a mathematical relation to the other two points. In short, the nomograph is a graphical tool for the solving of problems.

In common usage the terms chart, diagram, and graph overlap and are often used to describe the same item. Here, however, they will be treated separately.

Tables

A table is a condensed tabulation of data or information. It consists of two or more, columns of entries, the first column of which contains the name (or symbol) or the numerical value of some entity under a basic set of conditions. Other columns may contain values of the basic entity under other conditions which may be applied to it.

Tables are, by definition, columns of numbers. The mind cannot visualize the relationship of quantities from a list of numbers; therefore, one must be careful to use tables where exact values of one variable with respect to another are desired, not where an overall trend is sought.

How To Make a Table

To construct a table one chooses the independent variable, that is, the quantity which the operator can select at will. For example, in a table of squares and square roots of numbers, the number itself is the independent variable since the person using the table chooses the number in which he is interested, independent of the other numbers in the table.

The independent variable is generally placed in the most left hand column of the table under a suitable heading and is usually entered in the table as a "whole" or "round" number. Other numbers in the table are the dependent variables, so-called because their value depends on the selection of the independent variable. In the case of the square root table there are two dependent variables, which are placed in properly headed columns to the right of the independent variable column.

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Example: The Table of Squares and Square Roots of Numbers

Number	Square of Number	Square Root of Number
0	0	0
1	1	1.0
2	4	1.4142
3	9	1.7321
4	16	2.0000
5	25	2.2361

Interpolation

As mentioned above, the independent variable is usually placed in the table as a whole number. Sometimes, however, one desires information about a number between the whole numbers. For example, knowing that three feet contain 36 inches and four feet contain 48 inches, how many inches are contained in 3-1/6 feet? The process of finding the answer is termed interpolation. If three feet equal 36 inches and four feet equal 48 inches, 3-1/6 feet must equal the number of inches one-sixth of the distance between 36 and 48 inches, or 36 plus one-sixth of the number of inches from 36 to 48. Therefore, 3-1/6 feet equal $36+(48-36)/6$ inches or 38 inches. This is straight line interpolation.

One should be warned here against the use of straight line interpolation with variables which are not linearly related. For instance, one might suppose that the square of 4.5 is halfway between 16 and 25 or 20.5 Actually 4.5 squared is 20.25, and the use of 20.5 would introduce an error of 1.25 per cent. This percentage error becomes smaller as the numbers rise in value; therefore, it is not too significant in this particular case, but this type of error should be kept in mind when employing interpolation.

Other examples of useful tables in Sanitary Engineering are:

- Alkalinity equivalents of various chemicals
- Analysis of sewage sludge
- Areas of circles
- Atmospheric pressures at various altitudes
- Btu/ton of refuse—related to moisture content
- Carrying capacity of different size sewer pipe at various slopes
- Characteristics of chemicals
- Conversion factors from one system of measurement to another
- Degrees of hardness of water
- Equivalent weights and measures
- Fire flows required for various size cities
- Fire stream discharges for various nozzle sizes
- Friction of water pipes at different flow rates in different size pipes
- Logarithms of numbers
- Pipe Line capacity under different heads
- Pressure to head relationship
- Squares and square roots of numbers
- Temperature Conversion from °F to °C and vice versa
- Trigonometric functions
- Velocity of flow in pipes of different sizes at different flow rates
- Water requirements of various industries

The Symons

James George

James, the senior author of this article is a third generation water works man and is studying for his doctor's degree in June 1957, just 25 years after his father obtained his doctorate.

Charts

Charts differ from tables in that they show pictorally the relation of one item to others or the value of some entity in terms of another. They are particularly useful for explaining data to persons not familiar with a technical subject and are helpful in presenting annual reports to boards and commissions as well as to newspapers.

In general, charts fall into two catagories, those in which some geographical features are shown and those in which some entire quantity is divided up into parts, either by percentage or by actual value.

For example, if one were trying to explain that additional maintenance help at a plant was required, a *pie chart* would be an excellent method of showing how a typical working day is utilized. The quantity to be sub-divided would be an eight hour shift. A circle; i.e., a pie is divided into various sections: Sampling, operation, maintenance, clean up and meals. A time study would reveal how much of the eight hour shift the operator spends in performing each of these four duties.

Time spent is converted to percentage and the pie is split up so that the area of each of the four sections of the pie appears as a per cent of the whole area of the circle equal to the per cent time spent on the corresponding job. This operation is easily performed by using a protractor and remembering that every 3.6 degrees of a circle forms a wedge containing 1 per cent of the area. A pie chart such as this would indicate at a glance that a high proportion of the operators' time was spent at maintenance and would show the need for additional employees. The data used for developing the pie chart might be as follows:

Record at Plant

Job	Hours per Shift	Per Cent
Sampling	1	12.5
Operation	2¼	26.9
Maintenance	4	50.0
Clean up and Meals	¾	10.6
Total	8	100.0

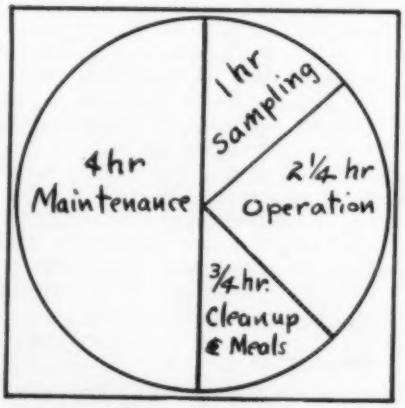

Fig. 1.—PIE Chart

The actual pie chart to fit these data is shown in Fig. 1.

The pie chart is useful particularly to indicate sources of revenue and disbursement of money for expenses. Other types of charts are:

Calendar charts which indicate schedules of dates on which repetitive action is required for proper operations. An important chart of this type is the schedule for preventive maintenance operations.

Line charts in which a single line or narrow bar is divided into parts with the divisions being marked with numerical values of the entity or its divisions under consideration. Examples of line charts are: pH zones or ranges of indicators; zones or ranges of pH in which chemical reactions in water or sewage take place; pH zone in which corrosion actions occur; geological strata as shown by well logs, etc.

Map charts consist of a map of some geographical section on which are shown special conditions or facts. Such charts may show weather conditions, contours, ground water elevations, geological strata, distribution system pressures, etc.

Diagrams

A diagram is an outline, plan or drawing intended to show what something is or how it works. One of the most common is the "flow diagram" which can be used for such diverse purposes as family trees, delegation of

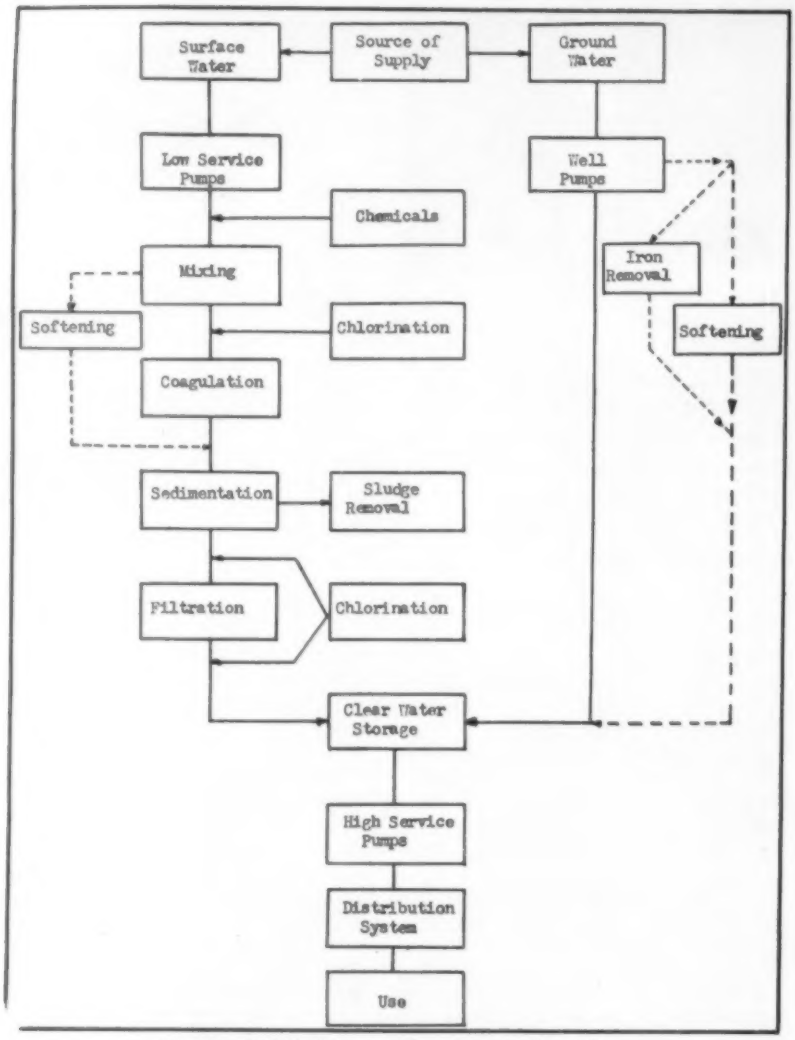

Fig. 2.—FLOW diagram of water supply system

authority within an organization, or the sequential progress of process operations as in the flow of water or sewage through a water supply or sewage disposal system or through the individual processes of a treatment plant, or of refuse through a composting plant.

To construct a diagram of liquid or solid flow through a processing plant each step in the treatment may be represented by a simple labeled box, or an accurate scale drawing of the equipment. Although in actual practice the flow through a plant may change direction many times and even double back on itself, in a flow diagram the process is laid out in a straight line. Other data may be included at pertinent points, e.g., the dentention time at each step, the cumulative time up to that step, or the time remaining until the process is completed, may be noted at that step. Usually chemical addition or waste removal is noted at the appropriate stage. A flow diagram through a conventional water supply system might be as shown in Fig. 2.

Graphs

Graphs are divided into two classes; line graphs and bar graphs. Line graphs are pictorial representations of tabular data showing how one quantity varies with respect to another. A bar graph is the pictorial representation of quantities which are not continuous variables of one another. For example, a graph of the water consumption per year in various cities around the country would be developed as a bar graph. Each city is independent of the next and all start at zero water consumption each year reaching some final total on December 31. A line connecting the plotted data would be meaningless.

Line Graphs

On the other hand, line graph would be used to plot such data as bacteria per ml remaining at the end of a ten minute contact time for various chlorine doses. In this case, all of the samples started with the same number of bacteria per ml and the number remaining may be directly related to chlorine dosage; therefore, a line graph is used. (Note: This is only an example and assumes that chlorine dose is directly related to bacterial kill; this may or may not be true).

To construct a line graph the decision must be made as to the independent and dependent variable. The choice is made on the same basis as mentioned in the discussion of tables. The independent variable is placed along the horizontal axis of the graph, termed the abcissa or "X" axis. Equal divisions to a convenient scale are marked off, and the values are labled both by name and units. The dependent variable is then plotted along the vertical axis. This axis is termed the ordinate or "Y" axis. Here also a convenient linear scale is chosen, numbered and labeled as to quantity and units. The title is usually placed at the top center or upper right hand corner of the graph. The title generally reads "Graph of Dependent Variable (Name) vs. Independent Variable (Name). Other pertinent information may be included. A graph of chlorine residual vs chlorine dose, for example, would appear as shown in Fig. 3.

Bar Graphs

A bar graph is similar to a line graph in many respects. The varying quantity is plotted up the vertical axis and is labeled in the same manner as above. The various items to be placed along the horizontal axis are spaced to make the graphs easy to read and the spacing has no numerical value. The axis is also labeled and the graph is generally titled in a manner as outlined above. The graph of water consumption of various cities in the country would appear as shown in Fig. 4.

Before leaving the subject of arithmetic graphs, that is graphs in which the graduations of the axes are linear, it would be well to discuss some of the more specialized problems of graph construction. Two problems of interest are: 1) How to represent large numbers, and 2) When to leave the zero or origin point off the graph.

The problem of how to place large number on a graph without cluttering up the scales with zeros can be solved many different ways. The simplest, however, is to chose some common factor, hundreds, thousands, millions, etc., that appear in each

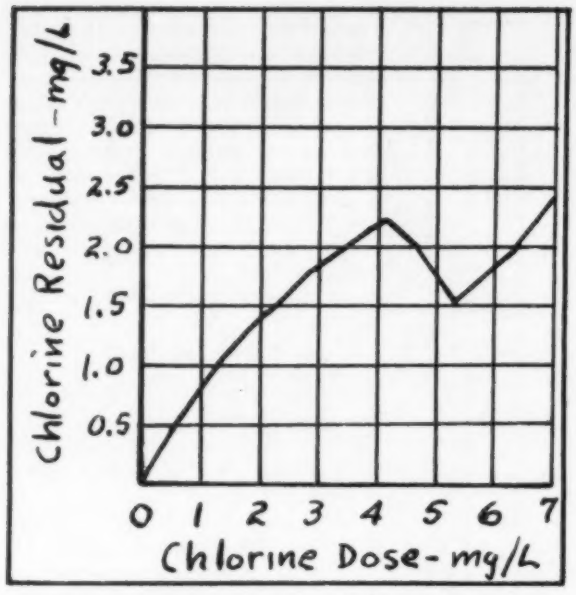

Fig. 3.—LINE graph of chlorine residual

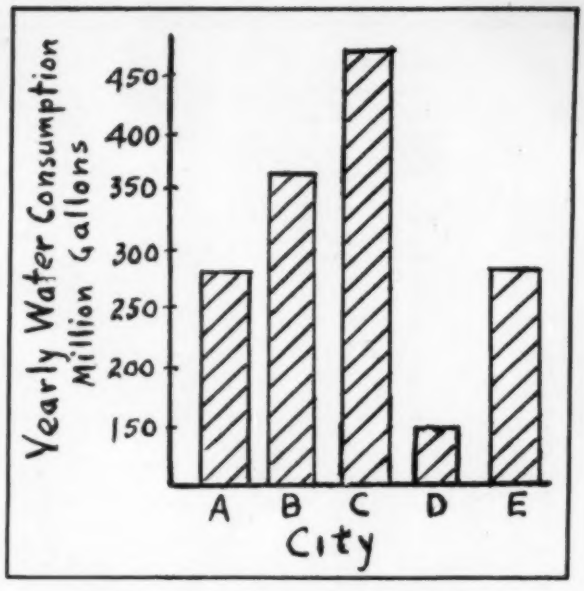

Fig. 4.—BAR graph of water consumption

figure and to remove it, leaving convenient numbers on the axis. Care must be taken to make note of this process when the units of the axis are stated.

For example, a graph of The Population in the United States vs. Years would have millions removed along the population axis for convenience as in Fig. 5. Figure 5 illustrates the other point, when to leave zero off of the graph. Most graphs are drawn on 8½ by 11 inch paper. By placing population along the eleven inch side of the paper and by discarding the unused population numbers, that is zero to 75 million, the remaining figures can be stretched to make the curve rise very steeply. This can be mis-leading to the uninformed.

A more accurate picture of the growth of population in these United States would be given by a graph with all of the population axis presented. Therefore, when it is desirable to present an accurate picture of conditions to the layman it is wise not to try axis stretching. For technical use around the plant, however, it is foolish not to make graphs as accurate and usable as possible by stretching the scales as much as possible. To include any unused portions of either axis is a waste of space.

Meaning of Slope

An important concept to understand is the slope of a graph. Slope is defined as the change of the dependent variable for a unit change of the independent variable. This means that the slope of a curve is the rate or change of the dependent variable. For example, in the laying of mains or sewers, the term "per cent grade" (slope) is used. A water or sewer with a 6 per cent grade or slope rises or falls six feet in elevation in every 100 feet of horizontal length. The rate of change of the elevation of the pipe invert is six feet per 100 feet of length.

Figure 6 shows an example of pump operating costs versus daily pumpage. If the rate of increase in operating costs per unit of pumpage is required, it is necessary to determine the slope of the curve (straight line). This is done by dividing the rise of the line by the corresponding run. In this case distance "A" ($20 per day) is divided by distance "B" (3.3-1.1mgd, or 2.2mgd pumped). The slope then is $20/2.2 or $9.09 per mgd pumped.

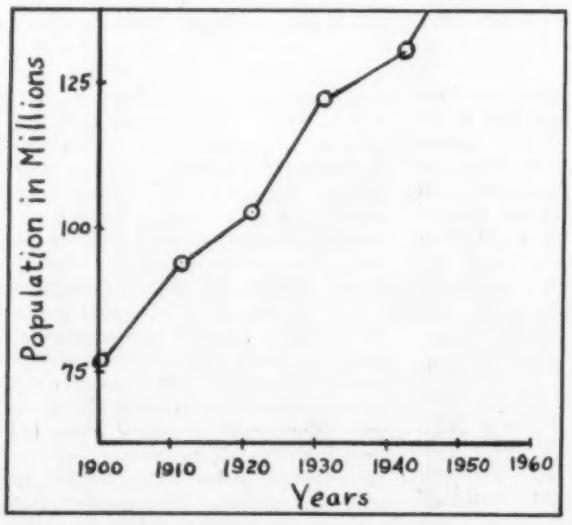

Fig. 5.—LINE graph showing y intercept and large numbers

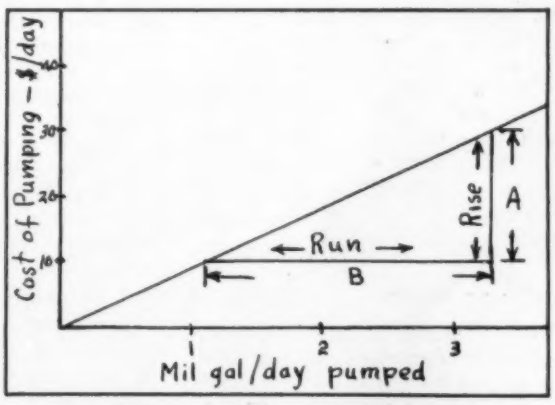

Fig. 6.—LINE graph showing meaning of slope

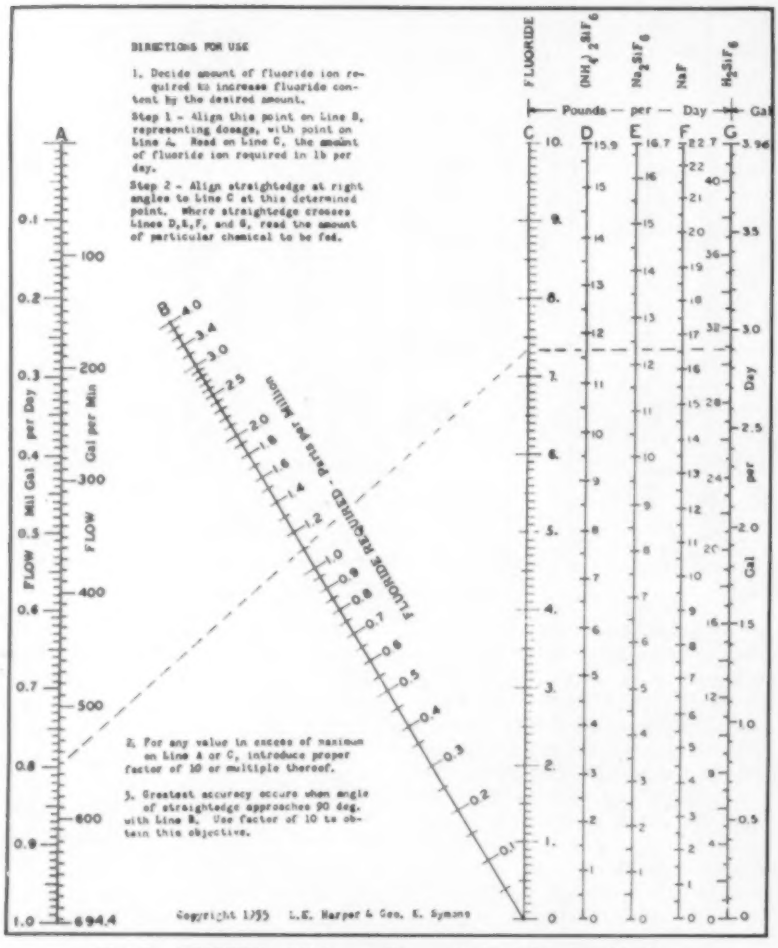
DIRECTIONS FOR USE
1. Decide amount of fluoride ion required to increase fluoride content by the desired amount.
Step 1 - Align this point on Line B, representing dosage, with point on Line A. Read on Line C, the amount of fluoride ion required in lb per day.
Step 2 - Align straightedge at right angles to Line C at this determined point. Where straightedge crosses Lines D,E,F, and G, read the amount of particular chemical to be fed.
2. For any value in excess of maximum on Line A or C, introduce proper factor of 10 or multiple thereof.
3. Greatest accuracy occurs when angle of straightedge approaches 90 deg. with Line B. Use factor of 10 to obtain this objective.
FLUORIDE REQUIRED - PARTS PER MILLION
FLOW Mil Gal per Day
FLOW Gal per Min
FLUORIDE
Pounds per Day
Day
Gal
Copyright 1955 L.E. Harper & Geo. E. Symons

Fig. 7.—EXAMPLE of Z type alignment chart for fluoridation

Equations of Graphs

The graphs disscussed thus far have been of the linear type, that is "y" the dependent variable, is equal to "x" the independent variable, times the slope "m"; This relation may be expressed by the equation, $y=mx$.

In some cases the plot of the data does not pass through the zero point on both axes. That is, when the "x" value of zero, the line passes through some value on the y intercept other than zero; this value is termed the "y" intercept and this intercept is expressed as "b" in the equation which then takes the general form for linear graphs of $y=mx+b$.

Often the general equation of the measured data does not agree with the straight line form.

Logarithmic Graphs

Two alternate general equations which are often used to represent data are: $y=a^x$ and $y=x^m$, where "a" and "m" are constants. Examining the first of these alternate equations, it is seen that taking the logarithm of both sides of the equation yields $(\log y)=(x)\ (\log a)$. The quantity "log a" is a constant of some numerical value; therefore the equation really is $(\log y)=(K)(x)$. This equation is of the linear or straight line type if "log y" were plotted on the "y" axis and "x" on the "x" axis.

It would be a tedious procedure to have to obtain the logarithm of the dependent variable for each datum point before plotting, therefore special "semi-log" graph paper has been devised so that both variables may be plotted directly and straight line graphs will result.

A typical curve of the "semi-log" type is obtained by plotting the Per Cent Transmission vs. Concentration for use in determining unknown concentrations of some ion by the standard colormetric tests using a spectrophotometer. The equation of the curve is $\log\ (\%T)=(K)(\text{Concentration})$, a straight line on "semi-log" graph paper.

The second equation above, $y=x^m$, becomes $(\log y)=(m)\ (\log x)$ when the logarithm of both sides of the equation is taken. In this case to obtain a straight line on arithmetic paper the logarithm of both the dependent and independent variable must be computed and plotted. Again this is inconvenient and special graph paper, "log-log" graph paper, has been developed to allow direct plotting of both variables.

An example of the "log-log" type equation is that for pipe flow; $H_L=(K)\ (Q^{1.85})$. In logarithmic form this becomes $(\log H_L)=(1.85)\ (\log Q)+(\log K)$. It is seen that this is the typical $y=mx+b$ type of equation. Plotting Head Loss vs. Flow on "log-log" graph paper yields a straight line.

Nomographs

An alignment chart, also termed a nomograph or nomogram is one of the most useful mathematical tools available to an operator. The simplicity of using such charts has made them quite popular, both with non-technical and technical personnel.

Alignment charts are used to show the relationship between three, four, and five or more variables and are particularly useful in plant operation where it is possible to calculate operation results, quickly and easily. Such calculations as pounds of chemical dosage determined from flow rate and dosage rate, or production quantities from analytical data, per cent removals, rates of flow and many other items are among the useful information that can be calculated by alignment charts.

The simplest alignment chart consists of three parallel lines each of which has a scale representing one of the variables in the mathematical equation or relationship to be solved. The scales, however, do not have to be parallel and may in fact look like a Z or have some other angular, curved or spacial relations.

In the discussions above, the construction of diagrams and graphs utilized graphical scales. Graphical scales may be either curved or straight lines graduated with a set of numbers arranged in order of magnitude. When the distances between points are equal, it is termed a uniform scale; when the distances are unequal, it is a non-uniform scale.

Unlike graphs and diagrams, nomographs or alignment charts do not make use of graphical scales but employ instead, what are termed "functional" scales. In a "functional" scale the distances between the graduations are proportional to the value of the variable being sought. Fre-

quently, a logarithmic scale is employed to establish this proportionality, although other proportionality factors may be used. In alignment charts the distances are laid off from an initial point on the scale, not necessarily the zero point.

How to Make a Nomograph

The construction of alignment charts can be a complicated art for complicated relations, but for the usual calculations in a water, sewage, or waste plant, the development of a useful alignment chart is relatively easy.

For a short cut to the construction of a parallel alignment chart (for example relation of flow, chemical dosage and dosage rates) follow these steps:

1. Draw two parallel lines a convenient distance apart.
2. Graduate one scale (A) from top to bottom in logarithmic divisions to cover the entire range of values to be covered by the data collected on one variable, say flow in mgd.
3. Graduate the second scale (B) in logarithmic divisions for the entire range of values to be covered by the second variable, say pounds per 24 hours of chemicals.
4. To determine the location of the third "C" scale (dosage in ppm) draw two light guide lines, one connecting the top value on scale A with the bottom value on Scale B, and the other connecting the bottom value on scale A with the top value on scale B. Where these lines cross, draw a vertical line parallel to lines A and B.
5. To determine the scale divisions on scale C, place a straightedge across the upper part of scales A and B for two particular values and mark the point where the straight edge crosses line C. Calculate the value of this point from the equation ppm (dosage rate) = (lb/day ÷ (8.34 x mgd)

Repeat this operation for two values on scales A and B, in the lower parts of the scales.

Having located two values on scale C, divide the distance in between the two points into the number of divisions representing the number of whole values between the two values. These divisions may be logarithmic or approximately, but not necessarily, so.

Some persons prefer to use scale divisions which are equal in value. This arrangement can be accomplished for at least two scales by using a Z type nomograph as shown in Fig. 7. In this case, the "C" scale is divided in approximately logarithmic divisions. To locate the points on this scale it was necessary to calculate the value for each point for two different rates of flow and locate it graphically by straightedge connecting those two different flow rates with the dosage in lb per day for that dosage rate and those two flow rates. Where the lines crossed represents the location of the value in ppm on the "C" scale. This is a somewhat tedious procedure but effective.

In Fig. 7, more than one scale is included in the B scale as may be done in many cases.

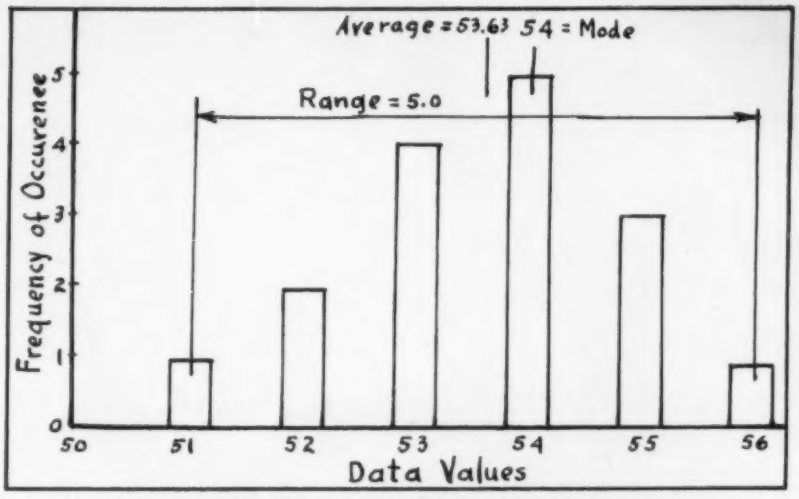

Fig. 8.—EXAMPLE of "average," "mode" and "range"

Some Mathematical Terms of Importance

To complete the mathematical picture, it is desirable to define four common terms: 1) Average, 2) Mode, 3) Range and 4) Median.

All of these terms attempt to "tell a story" about experimental data without presenting all of the data taken. Suppose an operator measures the suspended solids in an aeration tank every day at 11:00 a.m. and suppose the superintendent wishes this information. By reporting the average, mode, and range of the data to the superintendent, he will have all of the information required without having to examine all of the data. These quantities give a picture of all of the data.

The *average* of data is the sum of all of the data divided by the number of pieces of data present. The average assumes the natural variation in data will cancel itself out, that is there will be the same number of high results as low ones. This may or may not be true, but the average of data is an important property. The "average" is also termed the "mean".

The *mode* of data is the value of the data that appears most frequently, that is, it is the most likely to appear. As an example, the mode is the value reported by the Most Probable Number (MPN) of microorganisms. The mode differs from the average by the fact that the mode is not affected by a few very high or very low results. For example, in the data 2,2,3,5,5,5,5,5,7,30 the mode is five, but the average is 6.9. The difference between the two values would indicate that some very high values were present, as is the case.

All data has some scatter, that is, there are some high and some low results. *Range* is a measure of this scatter. The range of data is the difference between the highest and lowest numerical value. Range is a good measure of the natural variation of data except in the cases of tests where a single piece of data could be grossly in error. This error will cause an undesirable increase in the range and it will no longer be a good representative of the consistency. These cases, however, do not occur frequently.

If the average value of suspended solids in an aeration tank is 1500 mg/L and the range is 500 mg/L this means that all of the values of suspended solids measured would lie somewhere between 1250 and 1750 mg/L.

These three quantities (average, mode and range) are shown in Fig. 8. A combination of all three will tell much about the characteristics of data.

In cases where daily data are tabulated for the month or the year, some operators use the median value as being more representative of the true "average" condition for the month than the arithmetical average. The "median" is that value which lies midway in numerical sequence between the highest and the lowest value; for example the sixteenth value in a list of 31 numbers when listed in descend-

ing or ascending order of numerical value.

In many cases the *weighted average* value is of far more importance than the arithmetical average. For example, to obtain a weighted average suspended solids in ppm it is necessary to calculate total pounds of solids per day from daily flow and ppm; these values are then added and divided by the sum of the flows (times 8.34) for the period (say a month). This operation gives the weighted suspended solids in ppm for the month.

Summary

In the short space of one article, it is not possible to develop all of the details of how to collect, store and use data. Neither is it possible to cover the subject of mathematics as it is used and useful to water and sewage plant operators. This article has not attempted to do either, but has been developed to acquaint the reader with some of the most useful tools with respect to data handling.

The mathematically minded student and engineer will find most helpful and useful this book on alignment charts:

"Nomography" by A. S. Levens, published by John Wiley & Sons.

Also students, operators and engineers will find these two articles both helpful and interesting.

"Graphical Approach to Statistics" by C. J. Velz; *Wat. & Sew Wks.* 99: R-106 (April 1952)

"Survey of Elementary Mathematics" by Warren K. Eglof; *Wat. & Sew Wks.* 95: R-55 (April 1943)

Albert A. Smoot, Chairman of the Authority, Speaking

Sludge Control House: a haven in the storm

ALEXANDRIA, VIRGINIA DEDICATES NEW SEWAGE TREATMENT PLANT

Forced by the inclement weather of Dec. 14th to abandon plans for an outdoor setting, the Alexandria, (Va.) Sanitation Authority staged the dedication ceremonies at its new sewage treatment plant in its colonial styled Sludge Control Building (see picture). Flowers and music and the identifying multi-colored sludge piping and process equipment provided an appropriate haven for most of the approximately 200 "weather-proof" persons in attendance.

The Authority was presented with a flag by one of the local chapters of the D.A.R. which had been instrumental in arousing local public interest in the abatement of pollution of the Potomac River by producing and showing a movie of the revolting conditions that existed in the Potomac River.

The Honorable John A. K. Donovan, State Senator and Vice-Chairman of the Interstate Commission on the Potomac River Basin, hailed the construction of the plant as an important accomplishment in the Commission's program to abate pollution in the Washington Metropolitan Area, because it is the first major municipal plant in the area to provide secondary treatment of its wastes. The Honorable Leroy S. Bendheim, Mayor of Alexandria, and the Honorable Joseph H. Freehill, Chairman of the Board of County Supervisors of Fairfax County, characterized the Authority's program as a striking example of achieving cooperative solutions to regional problems.

Mrs. C. L. Watkins, widow of the late Director of Public Works of Alexandria, unveiled the dedication plaque. Mr. Watkins had been instrumental in securing official recognition of the need for the sewage treatment plant and had served as one of the Authority's consultants.

An open house plant inspection tour followed the dedication ceremonies and the Authority held similar open house tours on the following two afternoons.

The 18 mgd plant provides single stage high-rate trickling filter treatment to reduce the oxygen demand of the sewage by 75% or better. Five-point chlorination is provided for odor control disinfection and oxygen demand, as needed.

Two-stage sludge digestion and digested sludge elutriation, to reduce ferric chloride required in sludge dewatering on endless coil spring vacuum filters, is provided. The filter cake will be used for farm lands or a soil improver.

The $4,000,000 plant is part of the $8.2 million sewage disposal system which was placed in operation in July 1956. Designed by Greeley and Hansen, Engineers of Chicago, it is intended to serve a projected future population of 150,000 in Alexandria and portions of neighboring Fairfax County expected in 1973.

Ed Note: The Alexandria plant is to be the subject of an article in a future issue by James J. Corballis Jr., Engineer—Director of the Alexandria Va. Sanitation Authority.

"Better to do a little well, than a great deal badly."—*Socrates.*

"from Chicago"
the
aeration
story

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WIDE BAND AERATION +

SWING DIFFUSERS =

maximum oxygenation efficiency
for high treatment at low cost

Since their installation at the Lima, Ohio Sewage Treatment Plant shown above, Chicago Pump Company Swing Diffusers and Precision Tubes have operated for over a year with no problems whatsoever. Plant records show excellent results in high grade effluent for the aeration tanks with Chicago Pump Company equipment. From January through May, 1956 this plant handled an average of 8 M.G.D. using an average of 0.498 cubic feet of air per gallon of sewage.

Fine bubbles, provided by Chicago Pump Company Precision Diffusion Tubes, give far greater contact of air and sewage (for equivalent air volumes) due to increased bubble surface, and result in maximum oxygenation absorption.

Wide Band Aeration, through Chicago Pump Company Swing Diffusers, produces a wide mass of finely divided bubbles completely circulating through the entire tank contents, increasing contact efficiency while eliminating center "coring".

Swing Diffusers for wide band aeration provide flexible economical operation, continuous performance and easy accessibility. Individual units are easily raised for service without de-watering the tank.

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always specify "Chicago"

for pumping sludge and sewage
ENGINEERS PREFER
WEINMAN
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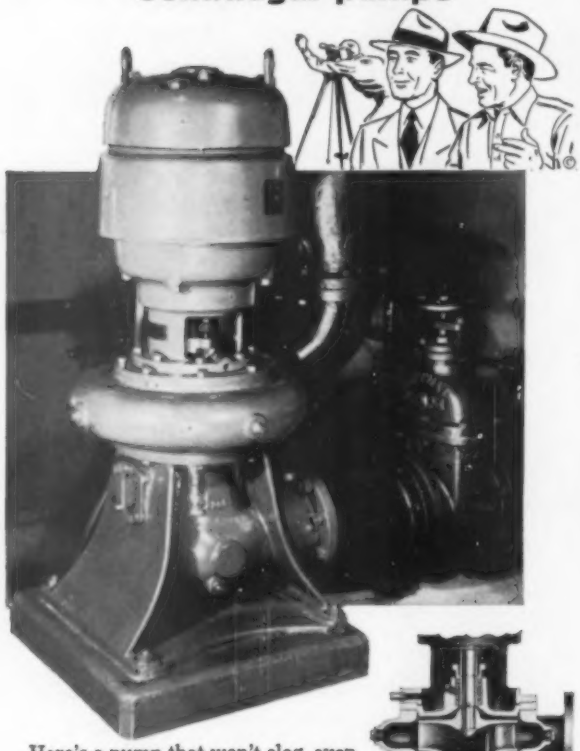

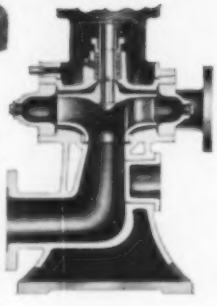

Here's a pump that won't clog, even under the heaviest loads. Designed by pump engineers with plenty of "know-how", WEINMAN TYPE "U" PUMPS will meet your most exacting requirements. They'll dependably handle liquids carrying large solids, stringy or fibrous trash, and material suspended in sludge form. To help prevent clogging in the discharge line, a scientifically designed, rugged, two-vane enclosed type impeller produces a steep head-capacity curve.

WEINMAN Type "U" Non-Clog Pumps can be used in dry pit installations, for submerged service or for low level suction with a high mounted motor. Three vertical and two horizontal types are available. Direct drive, belt drive or close-coupled construction. Capacities from 50 to 2300 g.p.m. with heads to 150 feet.

Install the pump that does a better job because it's designed better . . . Efficient, dependable, economical and durable WEINMAN Type "U" Non-Clog Centrifugal Pumps. Preferred by engineers, because it's built by engineers. If you have a pumping problem, non-clog or otherwise, contact your nearest WEINMAN Pump Specialist. He's listed in the yellow pages of your phone book, or write us.

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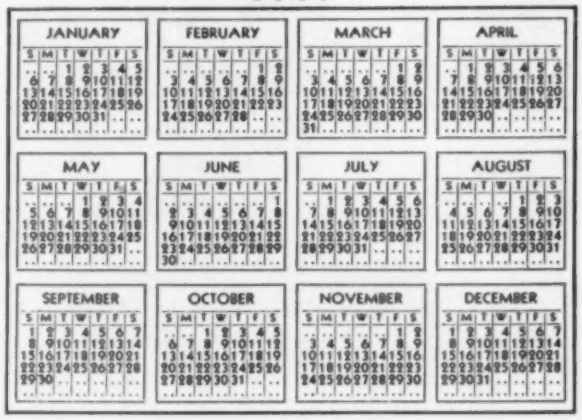

Jan. 24-26—Clemson, South Carolina (*Clemson College*)
ANNUAL SHORT SCHOOL FOR WATER & SEWAGE, Secy., T. P. Anderson, S. C. Water & Sewage Works, Assn., Wade Hampton Office Bldg., Columbia, S. C.

Jan. 29—New York, N. Y. (*Park Sheraton Hotel*)
NEW YORK SECTION, A.W.W.A., Mid-winter Luncheon; Secy., Kimball Blanchard, Rensselaer Valve Co., c/o Ludlow Valve Co., 11 W. 42nd St., New York, N. Y.

Jan. 31-Feb. 1—Wilmington, Calif. (*Los Angeles Harbor Junior College*)
6th ANNUAL INSTRUMENT SHORT COURSE, Secy., J. R. Wilson, 640 Fillmore Street, Fillmore, Calif.

Feb. 6-8—Indianapolis, Indiana (*Sheraton-Lincoln Hotel*)
INDIANA SECTION, A.W.W.A., Secy., Robert J. Becker, Indianapolis Water Co., 113 Monument Circle, Indianapolis 6, Ind.

Feb. 13-14—Portland, Maine
MAINE WATER UTILITIES ASSN., Secy., Gerard F. Laurin, 89 Western Ave., Augusta, Maine

Feb. 14—Newark, N. J. (*Hotel Essex House*)
NEW JERSEY SECTION, A.W.W.A., Secy., Albert F. Pleibel, 683 Prospect Street, Maplewood, N. J.

Feb. 18-22—Jackson, Miss. (*Hotel Heidelburg*)
AMERICAN SOCIETY CIVIL ENGINEERS, Exec. Secy., W. H. Wisely, 33 W. 39th Street, New York 18, N. Y.

Feb. 21—Boston, Mass. (*Hotel Statler*)
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

Mar. 3-6—White Sulphur Springs, Va. (*Greenbrier Hotel*)
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Secy. F. J. Van Antwerpen, 25 West 45th Street, New York 36, N. Y.

Mar. 3-8—College Station, Texas (*Texas A. & M. College*)
TEXAS WATER & SEWAGE WORKS ANNUAL SHORT SCHOOL, Secy., V. M. Ehlers, 2202 Indian Trail, Austin 3, Tex.

Mar. 5-9—Washington, D. C. (*Shoreham Hotel*)
AMERICAN CONCRETE PIPE ASSN., 49th Annual Convention; Howard F. Peckworth, Managing Director, American Concrete Pipe Assn., 228 N. LaSalle St., Chicago 1, Ill.

Mar. 13-15—Atlantic City, N. J. (*Traymore Hotel*)
NEW JERSEY SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Michael S. Kachorsky, P.O. Box 68, Manville, N. J.

Mar. 17-20—Charleston, S. C. (*Francis-Marion Hotel*)
SOUTHEASTERN SECTION, A.W.W.A., Secy. N. M. deJarnette, Div of Water Pollution Cont., State Dept. of Pub. Health, 245 State Office Bldg., Atlanta 3, Ga.

(*Continued on page* 86A)

Concrete Pipe for Cincinnati's Montgomery Road

Montgomery Road is a main artery that feeds into Cincinnati from the northeast. It carries a heavy load of traffic, so when an extension of a 36-inch water supply line was planned, ease of installation was an important consideration.

Prestressed concrete cylinder pipe turned out to be a happy choice. The job went smoothly for the contractor, A. F. Jelen & Son Co., and the highway was kept open to traffic even through congested districts like the one in the picture. Basic reason was the steel-and-rubber joint which is made quickly and easily . . . and incidentally makes a bottletight, yet flexible joint that is designed to take heavy traffic loads.

The line is 11,000 feet long and includes both 30 and 36-inch pipe. Along with 620 standard 16-foot lengths, the contractor installed 16 bends, 2 wyes, 3 reducers, 3 tees, 2 closure assemblies, one cross, and a number of short lengths and bevel adapters.

For information on any type of concrete pressure pipe for either water supply or pressure sewer lines, write Price Brothers Company, Dayton, Ohio.

Price Brothers

(Advertisement)

Mar. 18-20—Little Rock, Ark. (*Marion Hotel*)
ARKANSAS WATER & SEWAGE CONFERENCE, Secy., C. W. Oxford, University of Arkansas, Fayetteville, Ark.

Mar. 20-22—Chicago, Ill. (*LaSalle Hotel*)
ILLINOIS SECTION, A.W.W.A., Secy., Dewey W. Johnson, Cast Iron Pipe Reasearch Assn., 122 S. Michigan Ave., Chicago 3, Ill.

Mar. 20-22—Baton Rouge, La. (*Louisiana State University*)
20th ANNUAL SHORT COURSE FOR WATER & SEWAGE SUPTS. & OPERATORS, Secy. George H. West, P. O. Box 15, Lake Charles, La.

March 21—Boston, Mass. (*Hotel Statler*)
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

Apr. 2-4—Norman, Okla. (*University of Oklahoma*)
CORROSION CONTROL SHORT COURSE, R. V. James, Chairman, University of Oklahoma, Norman, Okla.

Apr. 4—Great Falls, Montana (*Rainbow Hotel*)
MONTANA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Harvey W. Taylor, Morrison & Maierle, Inc., Helena, Montana.

Apr. 4-5—Pullman, Wash. (*State College*)
8th ANNUAL PACIFIC NORTHWEST INDUSTRIAL WASTE CONFERENCE, Techincal Extension Services, State College of Washington, Pullman, Wash.

Apr. 4-6—Mesa, Arizona (*Maricopa Inn*)
ARIZONA SECTION, A.W.W.A. AND ARIZONA SEWAGE & WATER WORKS ASSN., Joint Meeting, Secy., H. C. Biggle-stone, Board of Fire, Underwriters of Pacific, 1106 Luhrs Tower, Phoenix, Ariz.

Apr. 5-6—Great Falls, Montana (*Rainbow Hotel*)
MONTANA SECTION, A.W.W.A., Secy., Arthur W. Clarkson, State Board of Health, Helena, Montana

Apr. 10-12—Wichita, Kansas (*Broadview Hotel*)
KANSAS SECTION, A.W.W.A., Secy., Harry W. Badley, Neptune Meter Co., 119 W. Cloud St., Salina, Kansas
(*Jointly With*)
KANSAS SEWAGE & INDUSTRIAL WASTES ASSN., Secy., James F. Aiken, Jr., Dept. of Public Health, 407 City Bldg., Wichita 2, Kansas

Apr. 10-12— Elmira, New York (*Mark Twain Hotel*)
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, Rensselaer Valve Co., c/o Ludlow Valve Mfg. Co., 11 W. 42nd St., New York 36, N. Y.

Apr. 11—Orono, Maine (*University of Maine*)
MAINE WATER UTILITIES ASSN., Secy., Gerald F. Laurin, 89 Western Ave., Augusta, Maine

Apr. 24-26—Lincoln, Neb. (*Cornhusker Hotel*)
NEBRASKA SECTION, A.W.W.A., Secy., John E. Olsson, 408 Sharp Bldg. Lincoln, Neb

Apr. 25—Pittsburgh, Pa. (*Mellon Inst. of Industrial Research*)
5th ANNUAL CLEAN STREAMS CONFERENCE, Secy., R. V. Wall, Penna. State Chamber of Commerce, State Chamber Bldg. Harrisburg, Pa.

May 1-4—SanDiego, Calif. (*El Cortez Hotel*)
CALIFORNIA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., R. J. Barletta, 719 South Loara St., Anaheim, Calif.

May 2-4—Tacoma, Wash. (*Winthrop Hotel*)
PACIFIC NORTHWEST SECTION, A.W.W.A., Secy., Fred D. Jones, Room 305 City Hall, Spokane, Wash.

May 12-17—Atlantic City, N. J. (*Convention Hall*)
A.W.W.A. CONVENTION, Secy., Harry E. Jordan, A.W.W.A. 2 Park Ave., New York 16, N. Y.

May 13-15—Lafayette, Ind. (*Purdue University*)
12th PURDUE INDUSTRIAL WASTE CONFERENCE, Chairman, Prof. Don. E. Bloodgood, C. E. Bldg., Purdue University, Lafayette, Indiana

May 22-24—Ocean City, Md. (*Commander Hotel*)
MARYLAND-DELAWARE WATER & SEWAGE ASSN., Secy., W. M. Bingley, 2411 N. Charles St., Baltimore 18, Md.

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The largest water tank repair company in the United States is at your service. Repairs guaranteed for 12 years—paint for 3 years.
Representatives in every state of the Union.
DIXIE TANK'S "SYMBOL" OF YOUR PROTECTION
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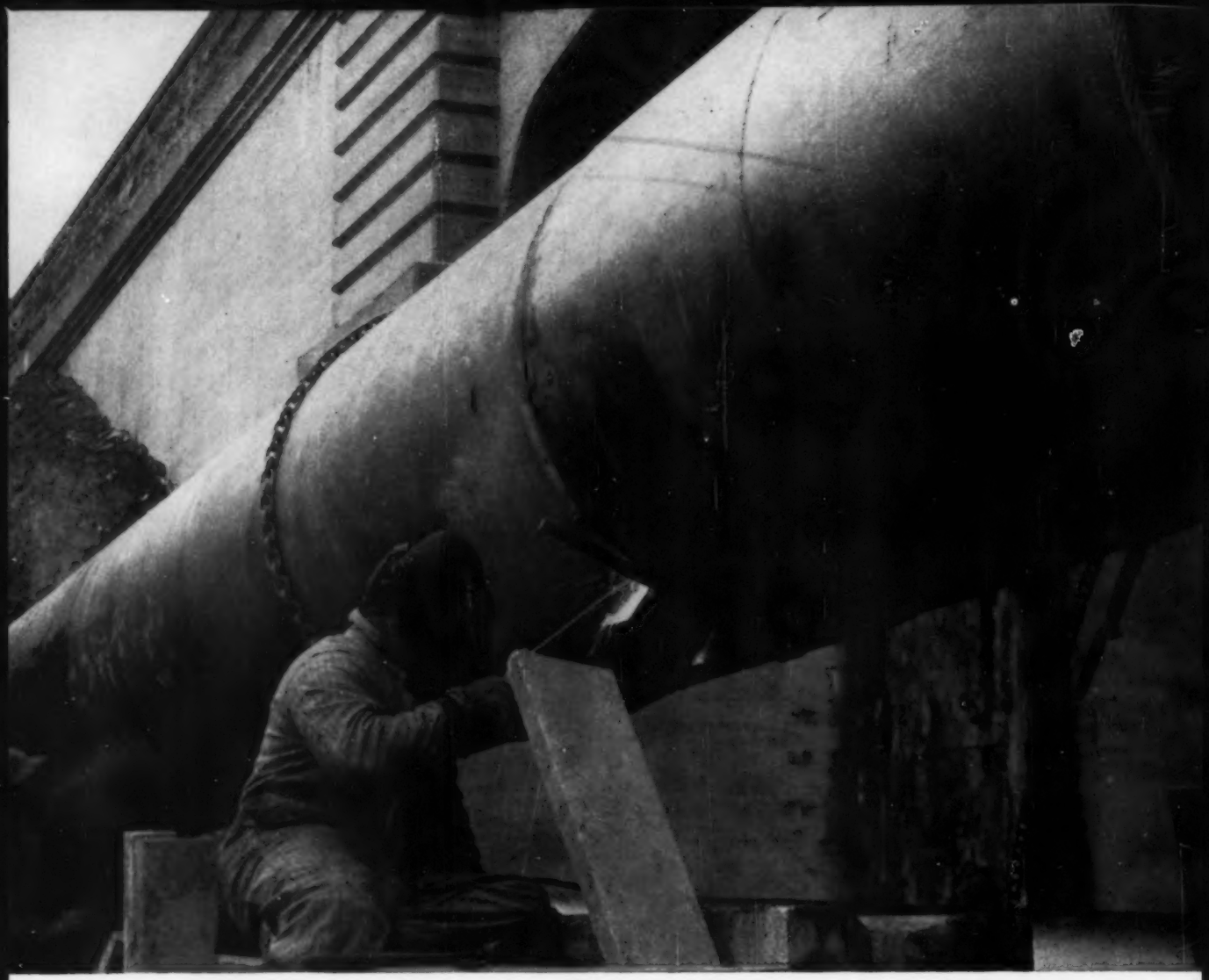


In Bay Village, Ohio—Cuyahoga County Engineers combat corrosion with over 37 tons of wrought iron plate for 48-inch sewage line

Corrosive threat plus inaccessible location added up to Wrought Iron for 48" O.D. sewage line

There was no question about the corrosion factors involved in the sewage line planned to serve Bay Village, Ohio. Compounding the problem was an almost inaccessible location that would make repair and maintenance difficult and expensive. And added to these considerations was the need for a material with sufficient structural strength to permit a 60-foot span between two trusses on either side of the valley the line had to cross. Cuyahoga County Sanitary Engineers, under the direction of Mr. John Puzenski, answered all these requirements with wrought iron. More than 37 tons of ½-inch wrought iron plate was fabricated into 48-inch diameter pipe and installed in approximately 270 feet of the sewage system.

Morgan Steel Products, Inc., Cleveland, Ohio, handled the fabrication. Installation work was done by The Utilities Construction Company, Cleveland, Ohio.

Our bulletin, *Wrought Iron for Sewage Treatment and Disposal Installations*, gives complete details on wrought iron's ability to last longer, at lower cost per year. Write for your copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Division Offices in Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N. Y.

Available in Canada and throughout the world

BYERS *Wrought Iron Tubular and Hot Rolled Products*

ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

W&SW **Spillway**

OVERFLOW FROM THE MAIN SECTION

Wahl New President; Dunstan New Secy. Pacific N.W. Sewage & I. W. Association

Trumbull Smith Elected Vice-President

Officers of the Association

From left: Gilbert H. Dunstan, secy.-treas.; H. Loren Thompson, national director, Federation Board of Control; Andrew J. Wahl, president; E. F. Eldridge, immediate past president and ex-officio member of executive committee. The new vice-president H. Trumbull Smith had left to attend the Federation Convention in Los Angeles before the picture was made.

The 186 registrants for the twenty-third annual meeting of the Pacific Northwest Sewage and Industrial Wastes Association, meeting in Boise, Idaho, elected the following officers:

A. J. "Andy" Wahl, superintendent of the Boise activated sludge sewage treatment plant, is the Association's new president, succeeding E. F. Eldridge, director and chief engineer of the Washington Pollution Control Commission, who becomes a member of the executive committee ex-officio.

The new vice-president is R. Trumbell Smith, division manager for Wallace and Tiernan, Inc., of Seattle, well known in the association for his excellent handling of the traditional annual breakfasts.

Gilbert H. Dunstan, professor of sanitary engineering, Washington State College, Pullman, was named secretary-treasurer, succeeding W. W. Saxton of the Washington Pollution Control Commission.

H. Loren Thompson, consulting engineer of Portland, Oregon, was elected national director to the F.S. & I.W.A. Board of Control, succeeding Emil C. Jensen who became vice-president of the F.S. & I.W.A. when John W. Cunningham of Portland, Ore., had to resign the office, due to illness.

Winners in the special Operators Annual Report Competition were the

(*Continued on page* 90*A*)

BEFORE and AFTER SALE "FLEXIBLE" is at your service!

Only "Flexible" has a nationwide group of Sales Engineers devoting their full time, in the field, to sewer-cleaning problems. Their years of practical experience assure you of sound advice in choosing equipment for your needs.

Sales Engineer McDermott, having recommended Flexible Bucket Machines to Gloucester, Mass., is seen here proving what they will do. After observing the results obtained in 1 hr. 15 min., the City Officials were "sold."

But, "Flexible" service does not end with the sale. Your men are instructed in the correct use of these machines, and periodic calls are made to assure performance comparable to the demonstration.

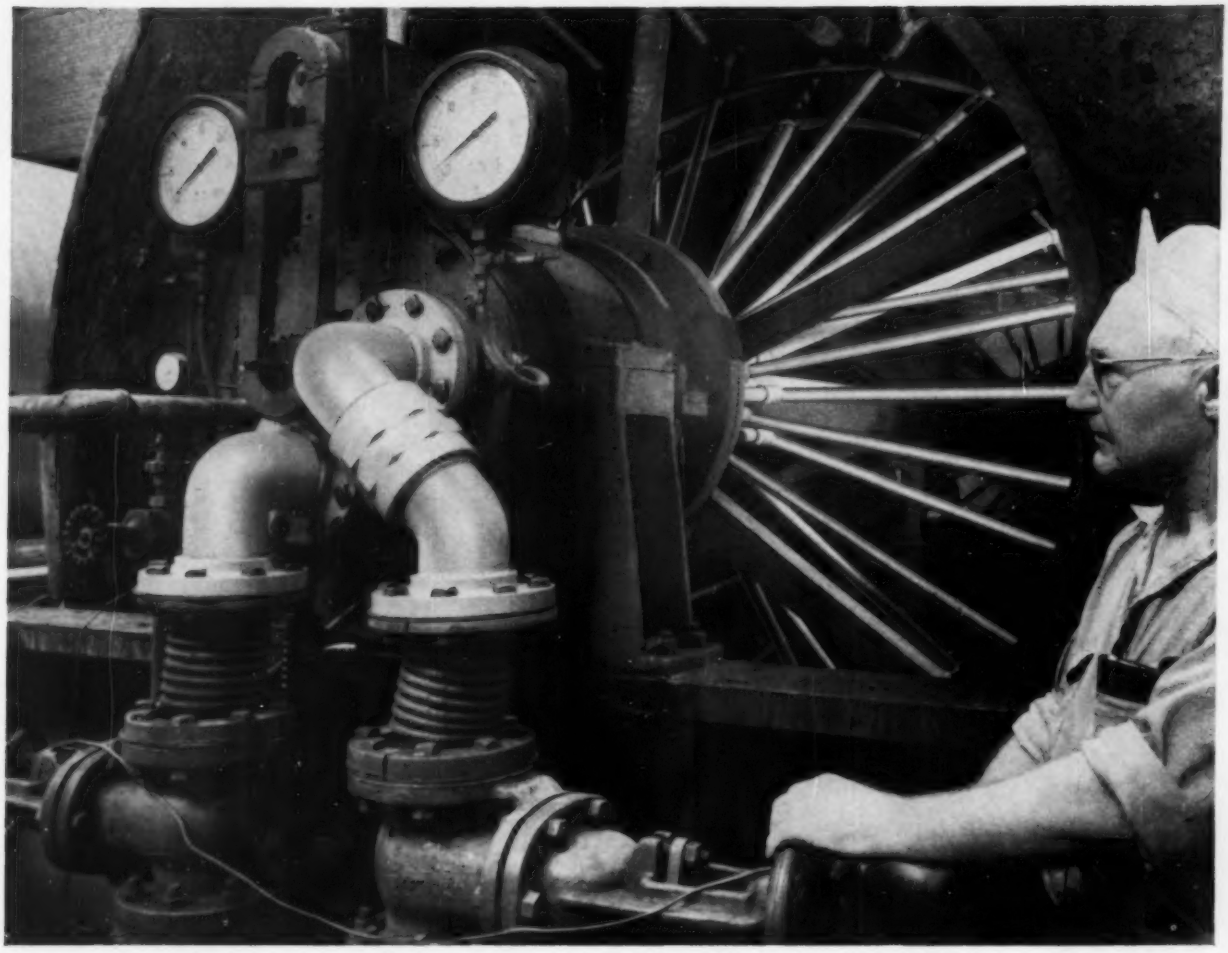
If this makes sense to you—"to buy only from the one firm offering these advantages"—arrange to see your nearby "Flexible" Sales Engineer soon.

FLEXIBLE INC.

3786 Durango Ave., Los Angeles 34, Calif.

(Distributors in Principal Cities)

USCOLITE PLASTIC PIPE



Pipeline of one of the Seven Wonders of American Engineering

Chicago's 403-million-dollar sewage disposal system every day processes 1200 million gallons of raw sewage. It's regarded by authorities as one of the seven engineering wonders of the nation.

Imagine the damaging effect on pipe of ferric chloride and other acidic chemicals used in the process! But this is not ordinary pipe in Chicago's great sewage disposal system. It is *Uscolite® Plastic Pipe.*

Uscolite Plastic Pipe was installed some eight years ago. Since then not a single leak has developed, not even a sign of weakness. The metal pipe it replaced had in some places been reduced to the thickness of a thumbnail!

The above rotary filter is but one of ninety-eight in the system. Each filter is 16 feet long, 11½ feet in diameter, contains 820 feet of 1" Uscolite Plastic Pipe and hundreds of Uscolite nozzles and additional fittings.

Uscolite Pipe and fittings are obtainable at our 28 District Sales Offices—each staffed with factory-trained engineers, at selected distributors, or write us at Rockefeller Center, New York 20, N.Y. In Canada, Dominion Rubber Co., Ltd.

NATIONAL SANITATION FOUNDATION SEAL OF APPROVAL AWARDED TO USCOLITE PIPE

Mechanical Goods Division

United States Rubber

following. For Group I (plants serving over 25,000 population), the award went to Lyman Ketcham and Donald Ross, Tacomo, Wash., with honorable mention to Tom A. Newell, Eugene, Ore., E. R. Lynd, Walla Walla, Wash., and Eugene Davis, Seattle. For Group II (plants serving 5,000 to 25,000) the winner was Kenneth L. Larson, Centralia, Wash. with honorable mention to Kenneth E. Mathews, Ellensburg, Wash., A. R. Strate, Nampa, Idaho, and Lee L. Mabee, Longview, Wash. For Group III (plants serving less than 5,000 population), the winner was Gerald G. Keeler, Grangeville, Idaho, with honorable mention to Philip E. LaFrance, Camas, Wash. W. E. Loftin, Gresham, Ore. and C. S. Zickefoose, Boise, Idaho.

The program committee under the chairmanship of Herbert C. Clare, of the U.S. Public Health Service, Portland, Ore., arranged two interesting general sessions, and one split session. A field trip was made to the Boise activated sludge treatment plant, followed by visits to trickling filter plants at Meridian, Nampa, and Caldwell, Idaho.

Ed Note: This meager account has been taken from a report by the new secretary-treasurer of the Pacific N.W. Assn. who is professor of Sanitary engineering at Washington State College, Pullman, Wash.

Tom Berrigan is Dead

Thomas A. Berrigan, former director and chief engineer of the Boston Metropolitan Sewage Works, died recently at his home in Westwood, Mass. He was 61 years old.

Mr. Berrigan was both an engineer and a lawyer, having been graduated by the Mass. Institute of Technology in 1916 and in 1930 won his law degree from Northeastern University.

After 20 years of service as director and chief engineer of the Metropolitan Sewage Commission of Boston, he retired about two years ago to establish a private practice of sanitary engineering and law. He served also as chairman of the Merrimack Valley Sewage Commission.

"Tom" Berrigan was active in the New England Sewage Works and Industrial Wastes Assn., and was a regular participant in the annual meetings of the Federation of Sewage Works Assns. He is to be remembered for his service as chairman of the Local Arrangements Committee, with the able assistance of Mrs. Berrigan, in working the Federation's 1949 convention in Boston, an outstanding, and long to be remembered, Federation convention.

here's all the equipment you need to sanitize with HTH

The convenience and the quick, positive chlorine action of HTH Granular make it ideal for water sanitizing at all points from source to faucet. And HTH effectiveness is matched by its economy.

Dry, non-dusty, easy to store and use . . . HTH offers 70% available chlorine for sure elimination of bacteria, algae, fungi and odors from reservoirs, wells, mains, spray ponds, filters and other danger spots.

Call your supply house today. Or write Olin Mathieson directly. You'll be surprised how many water treatment problems you can solve with HTH Granular.

HTH Granular is available in 100 lb. drums and cases of nine 5 lb. cans.

HTH® is a trademark

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OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

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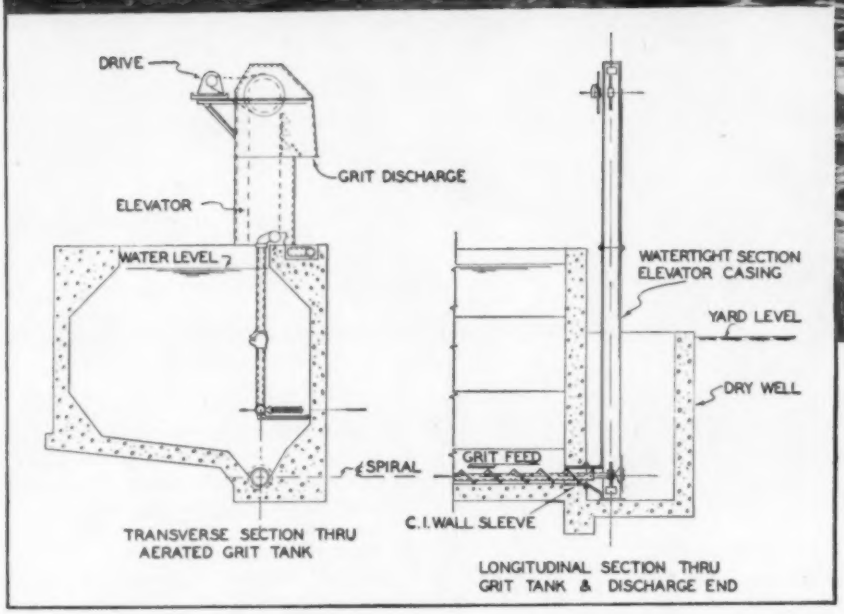
"Hey, Boss: haven't we tested enough? It's working fine!"



The grit basin is rectangular with a sloping bottom to collect the grit under the diffuser tubes. Below the water line, housing of the elevator and spiral conveyor is watertight. The spiral passes through a short tube between the grit chamber and the elevator to prevent grit from passing directly into the elevator boot.

This **JEFFREY** Grit Collector was designed especially for small treatment plants and aerated grit channels

● Grit is allowed to accumulate to considerable depth. Then the elevator is started and run until all grit is removed. The design is such that the spiral acts as a feeder to the elevator, delivering grit only as fast as the elevator can remove it. Can be used either in plain or in aerated grit channels.

Treatment plants throughout the country are Jeffrey equipped—in villages, towns and cities, serving 1500 to several millions; at industrial plants, airfields and similar projects. Jeffrey sanitation engineers offer you complete technical information on plant design and equipment.

Catalog 905 describes Jeffrey sanitation plant equipment. The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT • TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

W&SW

New Equipment

Robot Monitoring System For Water Purifying Systems

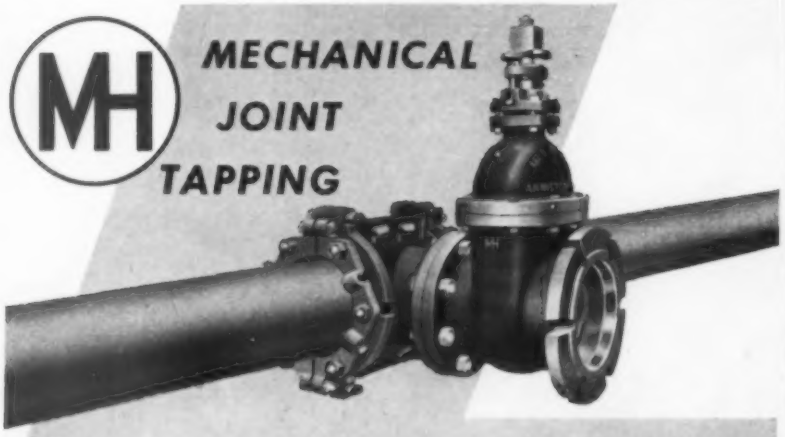
101

Minneapolis-Honeywell Industrial Division, Philadelphia, Pa., has announced that a robot monitoring system, designed by Minneapolis-Honeywell engineers, will oversee the operation of the largest of Philadelphia's five water purifying systems.

The $500,000 pneumatic-electronic control system will automatically adjust the amount of water being filtered or purified to meet the city's normal fluctuating demands. As demand rises, the system will automatically increase the amount of water being treated. When the demand slackens it will reduce the filtering rate.

The new system will enable the three-acre Torresdale plant to treat 420 millions of gallons of water daily, an increase of 88 per cent.

MH MECHANICAL JOINT TAPPING SLEEVE & VALVE



Tapping into a water main under pressure is a comparatively easy and simple operation with the use of an M & H Mechanical Joint Tapping Sleeve and Tapping Valve.

The sleeve has split-end gaskets and split glands, and may be used with Classes AB or CD pit cast pipe or Classes 100, 150, 200 or 250 centrifugally cast iron pipe. The glands have cup point set screws for centering them around the pipe. The sleeve has side and end gaskets of compound rubber which fit against each other to make a watertight seal.

The tapping valve is standard M & H design, double disc, parallel seat, NRS, and has a flange on one end for bolting to the tapping sleeve. The outlet end fits any standard tapping machine and may be ordered for either hub or mechanical joint pipe connection. Write or wire

M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF WALWORTH

Vacuum-Breaker Backcheck Valve For Hose Attached Appliances

102

Hercules Plastics Corp., New York, N.Y., has developed a vacuum-breaker backcheck valve that has been granted official approval by the Board of Standards & Appeals of The City of New York.

Designed specifically for use with all hose attached appliances, the valve protects home and community water supply systems from pollution at moments of water pressure failure which create a vacuum, drawing the contents of service pipe lines and appliance hoses back into the mains.

The Hercules valve is of molded Nylon and, is $2\frac{1}{16}$ inches in length with a $1\frac{3}{16}$ inch outside diameter, weighing $\frac{7}{8}$ ounce. It has a standard hose thread.

Corrosion-Resistance Relief And Back Pressure Valves

103

Milton Roy Co., Philadelphia, Pa., has available a line of relief valves and back pressure valves which can be used with corrosive fluid at pressures to 1500 psi and temperatures to 250 F. The top works of these valves are protected by Kel-F thermoplastic diaphragms.

Available in standard ¼, ½, ¾ and 1-inch sizes, these valves offer a wide range of pressure settings which are easily made with a screw driver. For high corrosion resistance, valve bodies are constructed of cast steel, 316 stainless steel, Carpenter #20, and Hastelloy C.

DIFFUSAIR SPARGERS* PROVED SUPERIOR

AN EXCLUSIVE W.P.E. DEVELOPMENT

Two activated sludge bays at Hyperion (L.A., Calif.) Sewage Treatment Plant equipped with DIFFUSAIR SPARGERS*. Remaining bays formerly used Saran-wrapped diffusers which are now being replaced by SPARGERS to do the same work at less cost. Bids were taken under a Los Angeles specification to "furnish 8000 W.P.E. SPARGERS or a proved equal". The low bidder, who previously disparaged SPARGERS, has exhibited the unit he will furnish—a direct copy of the W.P.E. SPARGERS.

As the number of installations of Walker Process DIFFUSAIR SPARGERS* increases, in sewage and industrial waste treatment, it becomes apparent that former conservative claims regarding results obtainable are simply statements of fact.

DIFFUSAIR SPARGERS* have demonstrated time and again over the past months that they are not just "equal to" but actually superior to other types of air-diffusion devices . . . proving in full-sized plant tests that they

WILL NOT CLOG
DELIVER MORE OXYGENATION EFFICIENCY AND HIGHER RATE OF TANK TURNOVER
DO NOT BUILD UP BACK PRESSURE
REQUIRE NO AIR FILTERS
ARE ECONOMICAL, SIMPLE AND EFFICIENT

Bulletin 22S61 presents complete details on DIFFUSAIR SPARGERS* and includes discussions on the use of aeration in the various steps in sewage and waste treatment. Write for your copy.

*PATENT APPLIED FOR

WALKER PROCESS EQUIPMENT INC.

Factory — Engineering Offices — Laboratories Aurora, Illinois

Two aeration bays at Philadelphia's Northeast Sewage Treatment Plant where DIFFUSAIR SPARGERS* are successfully installed on existing headers which formerly supported diffuser tubes. Bays are approximately 400'x22'6"x16' SWD. Individual Air Meters measure air being used.

Ralph A. Hoot, Plant Supt.

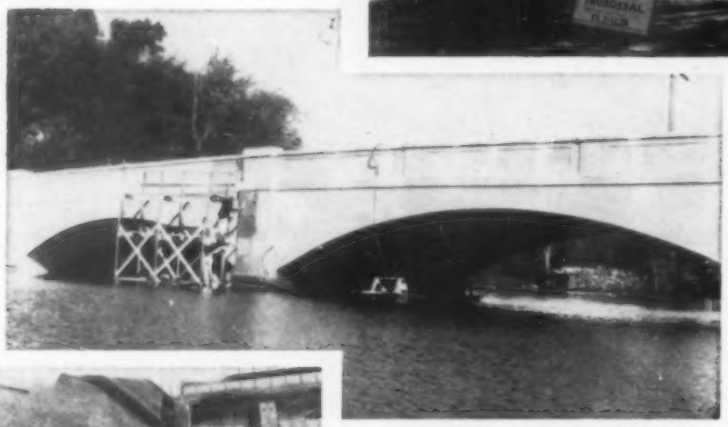
San Antonio selected DIFFUSAIR SPARGERS* for their new plant addition. SPARGERS are installed in two new bays each 350'x29'10"x15'0" W.D. Original bays are equipped with diffuser tubes on pivotal frames and also fixed plates.

W. N. Wells, Plant Supt.

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

It's *New Again* with THORITE and THOROSEAL

Freeze-thaw cycle following water and moisture penetration, also swelling of reinforcing rods from moisture contact, cause masonry destruction.



BRIDGE OVER CONCORD RIVER
ROUTE 3, BELLERICA, MASS.

Workmen on scaffold patch spalled and cracked concrete with THORITE and seal surface with THOROSEAL.

Area at left chipped to sound masonry. It will then be patched with THORITE *Nonshrink, Nonslump 20-Minute Set Patching Mortar*, without necessity of costly forming, finished by application of Thoroseal.

Request Circular No. 16 and 20.

Write for our 16 page "How to Do It"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA • CENTERVILLE, INDIANA

New Welded Grating

104

The Globe Company, Chicago, Ill., has developed the "Gold Nugget" welded grating, with an improved design that provides the primary load bar with 22% more strength and 14% less weight. The primary load bar is a miniature I-beam with all the advantages of a true structural member.

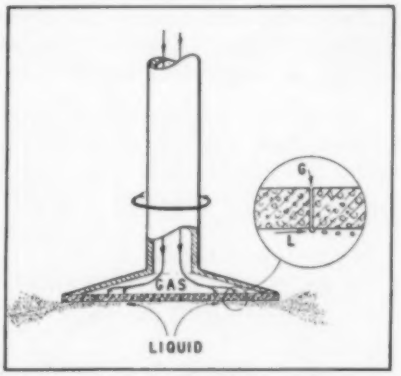
The new grating offers: ⅜ inch projection weld nugget for greater rigidity and strength; vertical alignment of the main load bars assured; all bars are load carrying bars; and an anti-skid pattern.

New Gas Dispersing Device For Aeration Use

105

R. E. Gunther, Princeton Junction, N. J. has developed a new type of gas dispersing device that has proved efficient in the aeration of aqueous media. The new device is said to be capable of creating so fine a dispersion of air in the liquid that solution of oxygen in it can take place efficiently and the injection of large excesses of air becomes unnecessary.

The apparatus consists of a hollow rotor mounted on a tubular shaft and with a porous stainless



steel disc covering the lower portion of the rotor. Spinning the rotor at high speeds creates a low pressure area between the porous disc and the liquid, and this causes the air in the rotor to be drawn down into the liquid. No pressurized air supply is required. As soon as air begins to emerge from a pore in the disc, the relative velocity between pore opening and liquid causes the liquid to shear away the forming bubble. Since the bubbles get no chance to grow to any appreciable size, the resulting dispersion is extremely fine.

Sewage SLUDGE

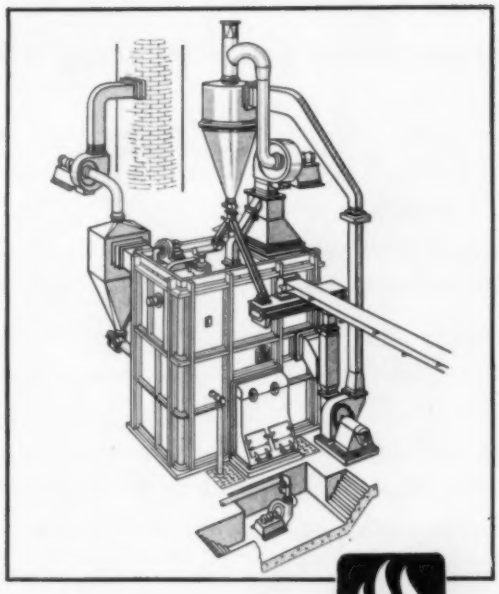
BURN IT!
SELL IT!

You can do both with the C-E Raymond System

For versatility alone, you can't beat the *C-E Raymond System of Flash Drying and Incineration!* With it, you can incinerate sewage sludge to a sterile ash...or flash-dry it to a fertilizer and soil conditioner that is readily marketed. Either operation can be performed alone, or combined in any proportion.

In either case, high-temperature deodorization of stack gases is available.

Whether you wish to incinerate or dry—look to the C-E Raymond System for the effective end to your sludge disposal problems. For specific recommendations for your community, get in touch with a C-E specialist at the office nearest you. He will be happy to work with you and your consultant.



C-E

B-930

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ALSO FLASH DRYING AND INCINERATION SYSTEMS FOR INDUSTRIAL WASTE DISPOSAL

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house footings ...HERE?

Right! – in spite of all the trees this Cleveland 110 is doing a fast job trenching for housing unit foundations

A highly maneuverable trencher is an absolute requirement for economical production to the accuracy required for building foundation trenches in conditions like these experienced by Algernon-Blair, Inc. of Montgomery, Ala. on this 127-unit housing project at Fort Eustis, Va. for the Corps of Engineers.

Here's what J. B. Snipes, Project Manager for Algernon-Blair, says about his Clevelands: "We are using Clevelands exclusively on the Fort Eustis project because of their excellent performance and dependability. We chose Clevelands originally because we consider them faster—and their superior maneuverability is a feature we particularly like on a project like this."

At the Road Show • Cleveland Trenchers and Backfillers • Exhibit 417

THE CLEVELAND TRENCHER CO.

20100 ST. CLAIR AVENUE • CLEVELAND 17, OHIO

Good Everywhere

New Protective Coating

106

Smith & Loveless Inc., Merriam, Kansas, has announced the availability of "Versapox", a high impact thermosetting type of material that when used in tanks, piping, sewage ejectors, underground pumping stations, settling basins, etc., provides protection from water, sewage, fumes, solvents, alkalies, fungus, acids, sand, grit, rocks, and other foreign matter.

"Versapox" will adhere to most non-waxy surfaces and is an excellent sealant for application to concrete, glass, wood, steel, plastic, and ceramics. It is not affected by temperatures ranging from subzero to well above 600° F.

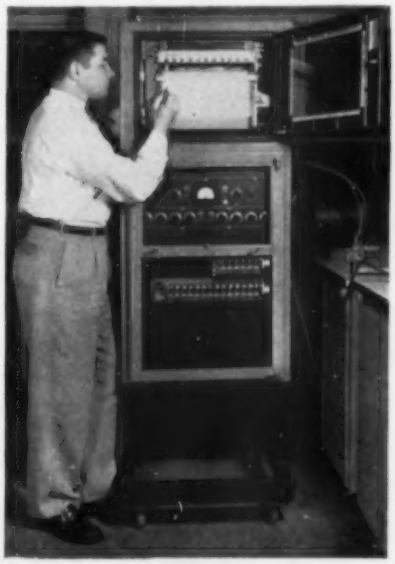
Originally compounded for use in lining the steel sewage ejector receivers manufactured by Smith & Loveless, it is now available for use in water, sewage and industrial plants.

Continuous Gas Chromatograph

107

Beckman Instruments, Inc., Scientific Instruments Div., Fullerton, Calif., has introduced the first continuous gas chromatographs designed specifically to analyze industrial gas streams.

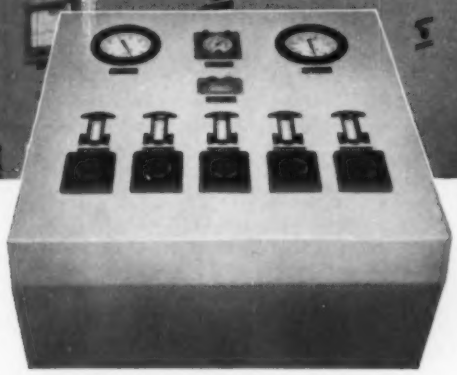
The new chromatograph is a compact, thoroughly engineered device designed to make continuous samplings of any gaseous proc-



ess stream. Each sample is automatically passed through a packed column of absorbent material which breaks the mixture into its

(*Continued on page 98A*)

Rugged, compact ***Differential Converters*** *can handle all remote transmission applications for flow rate and filter loss of head measurements.*



With Honeywell ***Filtermatic*** *systems, a complete filter plant can be operated from a single central panel (above)—or individual consoles can be provided for each filter (below).*

Honeywell *Filtermatic** Systems give you *centralized automatic* control of your filtration plant

YOU CAN put a new kind of operating economy and simplicity into your water filtration plant, with Honeywell *Filtermatic* systems. These modern filter control systems give you a unique combination of design, operating and maintenance features.

Flexible control. Filtration and backwashing can be regulated by any of a variety of methods, at the operator's discretion. He can choose manual, semi-automatic, or remote manual operation. Or he can have automatic control established by pre-set flow rates, clearwell level or water usage.

Flexible design. Free from limitations of cables and mechanical linkages, *Filtermatic* systems are easily designed into central control panels in laboratory or office. Or, individual operating consoles can be provided on the filter floor.

Simple installation. Components are compact . . . require less space in pipe gallery or on the operating floor. First cost is low, installation is easy on either new or existing filters.

Simple maintenance. Built of rugged elements, *Filtermatic* systems function continuously with minimum attention. Use of interchangeable units—the same *Differential Converter* transmitters, for instance, for level, flow rate, differential pressure—reduces spare parts requirements. The system uses clean, dry air, so pipe galleries stay clean and corrosion problems are reduced.

Ask your local Honeywell sales engineer to discuss your specific filter requirements . . . he's as near as your phone.

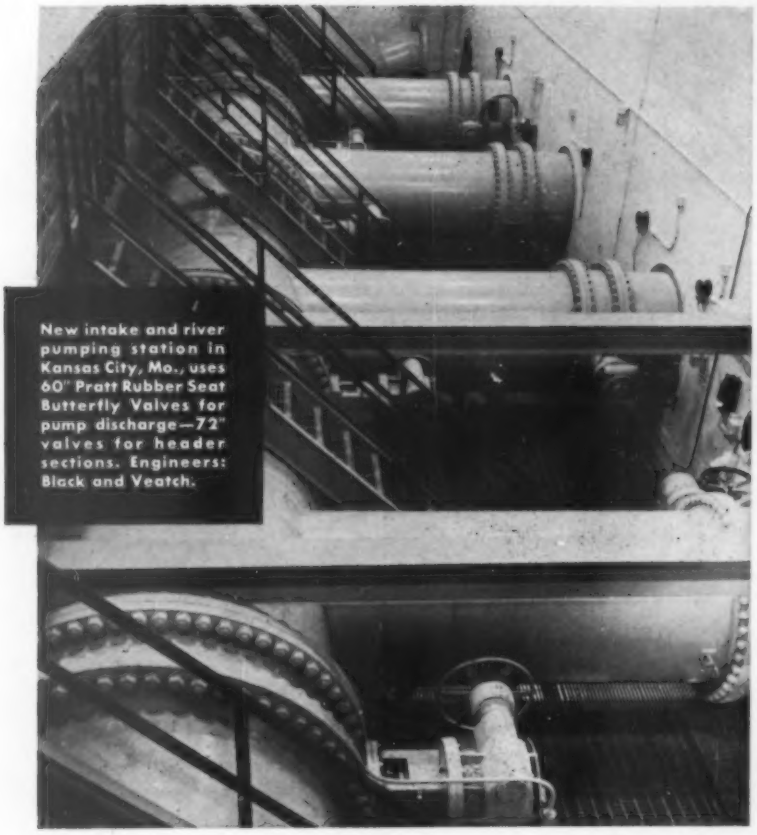
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

* Tradename of Minneapolis-Honeywell Regulator Co.



New intake and river pumping station in Kansas City, Mo., uses 60" Pratt Rubber Seat Butterfly Valves for pump discharge—72" valves for header sections. Engineers: Black and Veatch.

KANSAS CITY:

Rugged efficiency in a minimum space

Look! A modern pumping station with compact, unobtrusive large-diameter valves that require no more clearance than a standard pipe flange, and operators that are equally compact. Face-to-face dimensions of these 60" and 72" diameter Henry Pratt Rubber Seat Butterfly Valves are only 15" and 18" respectively.

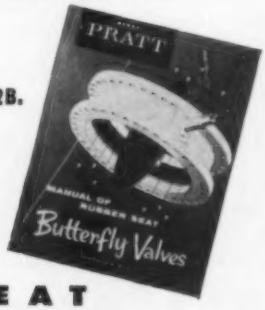
Specifying Pratt valves means important savings in space and installation costs—but even more important, economy through years of efficient maintenance-free operation.

Pratt originated the Rubber Seat Butterfly Valve and has installed more of them than any other manufacturer.

For valve design with a 50 year reputation for practical imagination, see Henry Pratt.

NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.

Write for Manual B-2B.



HENRY PRATT

RUBBER SEAT

Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

component parts, and then registers on a graph the percent of each chemical component present. This information can be fed into a relatively simple control system which can keep track of the reaction and automatically correct any deviations.

Chemical Clears Pipes of Roots And Fungus Growths

108

FX-Lab Co., Newark, N.J., has developed Formula FX-3 that provides a once-a-year treatment to clear and prevent clogging of sewer pipes and septic tank-cesspool drainage fields caused by tree roots, shrub roots, and fungus growths.

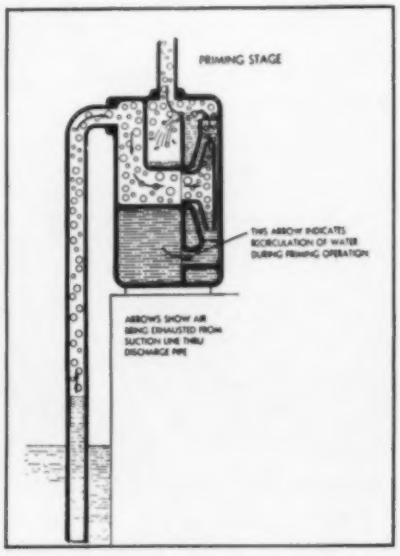
The new product consists of a crystalline formulation that attacks only the "drinking" mechanism of the roots, completely destroying them without harming any other part of the tree, shrub, or leaf. It will seal off the roots at that point and prevent all future growth.

Safe and easy to use, FX-3 is applied through the toilet bowl, and simply flushed to point of obstruction or penetration. It will not harm plumbing fixtures, or necessary bacteria within a septic tank or cesspool disposal system.

New Line of Self-priming Centrifugal Pumps

109

Goulds Pumps, Inc., Seneca Falls, New York, has developed an electric powered line of self-priming, closed or open impeller centrifugal pumps that eliminate the


PRIMING STAGE
THIS ARROW INDICATES RECIRCULATION OF WATER DURING PRIMING OPERATION
ARROWS SHOW AIR BEING EXHAUSTED FROM SUCTION LINE THRU DISCHARGE PIPE

(*Continued on page* 103*A*)

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each day...

142 billion gallons of water

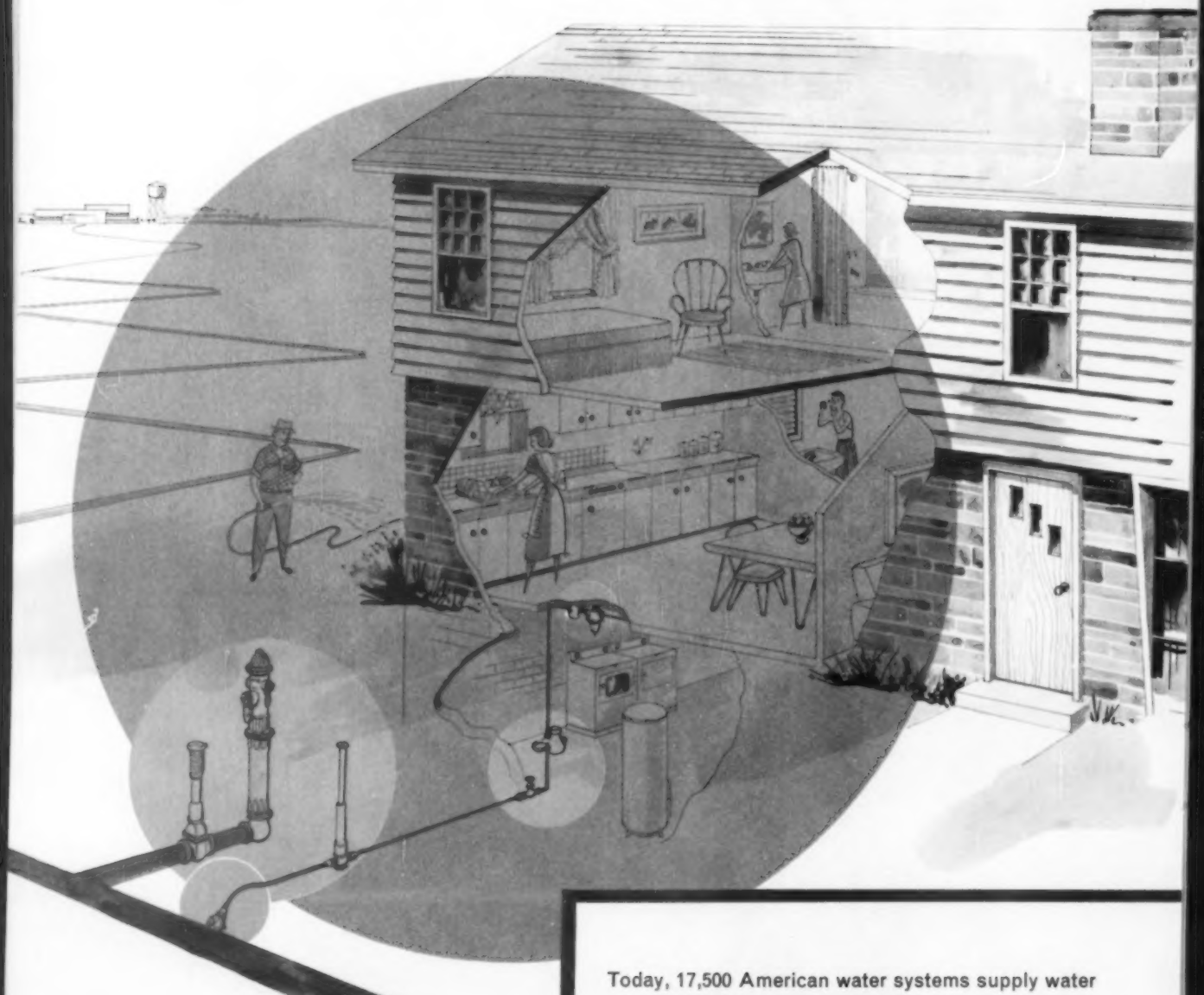
A hundred years ago, peddlers sold water for a penny a bucket from wagons in the streets. Today, modern, efficient water systems filter, purify and supply 142 billion gallons of water each day to consumers throughout the nation.

America's outstanding water industry has helped make this country a healthier, cleaner, better nation in which to live and work. For the outstanding progress in service and for an unfailing supply of pure, fresh water, Mueller Co. pays tribute to the vital water industry.

MUELLER CO. 100 YEAR QUALITY SERVING the Waterworks Industry

from buckets to billions

Serving 112,000,000



Today, 17,500 American water systems supply water to 112,000,000 homes and industries in the 48 states. An average of 154 gallons of water per person is used each day for a thousand and one purposes in the average American home.

MUELLER CO.
100 YEARS
QUALITY

American Homes and Industries

Today's immense water industry is a far cry from the old oaken bucket of a hundred years ago. But a look backward reveals the remarkable growth and development in the field of water treatment and distribution.

The first public water system was in Boston in 1642; and, 150 years later, only 17 systems were in operation in America. In 1829, water for consumption was first treated, at Lynchburg, Virginia, by settling basins that removed silt from raw water. Fifty years elapsed before the first practical method of water treatment by coagulation, sedimentation and filtration was developed to improve the public water supply of Vicksburg, Mississippi.

Thus, the last 75 years have seen the development of the modern water industry and present-day methods of treatment and distribution.

It was previous to this period that Hieronymous Mueller founded Mueller Co. in 1857 at Decatur, Illinois. He was appointed city plumber of Decatur in 1871, charged with plumbing and adding new services to that city's mains. This led to his invention of the original Mueller tapping machine in 1872, improved models of which are now in use throughout the water industry.

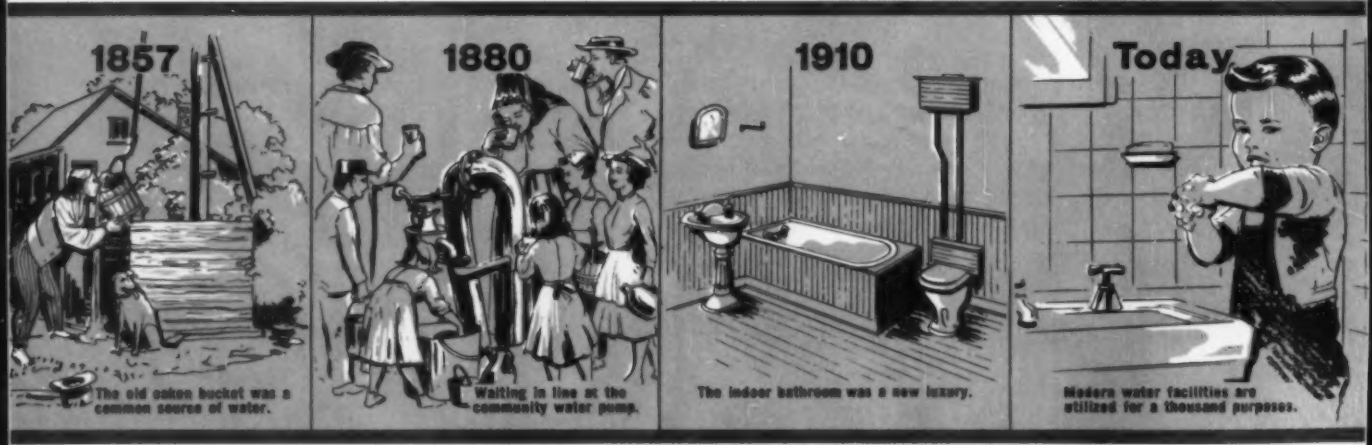
Another milestone for water was the use of 42″ metal pipe for service at Newark, New Jersey, in 1892. Wooden mains, the mainstay of early water works, were gradually replaced with long-lasting cast-iron pipe. Copper pipe, introduced to the industry in 1924, is now widely used to combat corrosion in water systems.

A major step, that guided the development and growth of the industry, was the formation of the American Water Works Association in 1881. Professional water works men bonded together in an association where they could share experiences and work out common problems for the benefit of all. For 75 years, this organization, which now numbers 10,000 water works men, has led the growth and progress of the industry. Mueller Co. was one of the first five associate members, joining the organization a week after its formation.

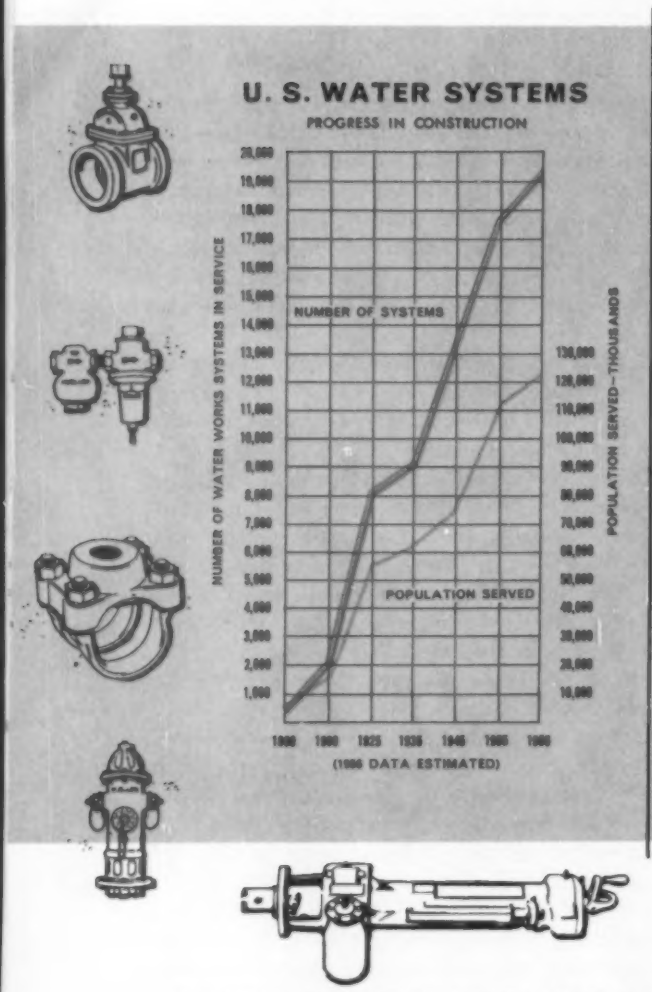
The 656 meager water systems, supplying service to 10,000,000 consumers in 1880, multiplied to the modern network of 17,500 systems supplying 112,000,000 homes and industries today.

Electric power producers and industrial users are the largest consumers of water, each requiring 60 billion gallons daily. Individual consumers are least demanding, requiring only 17 billion gallons each day. Five and one-half billion gallons are consumed in rural areas. This tremendous volume portrays the great growth in the service of our water systems, which, just 70 years ago, provided only 40.9 billion gallons of water daily.

Water works construction has kept pace with the growing water need. During the past quarter century, 4,575 water systems greatly expanded their services and 16,000 new systems have been installed. Construction budgets generally have quadrupled, setting an all-time high in 1956 of about $272,908,000, a 50 per cent increase over 1955's budget. This huge construction program is brought about by a number of major cities modernizing and enlarging their water distribution systems and by the increasing need for extensions of water service to new suburban areas.


1857
The old oaken bucket was a common source of water.
1880
Waiting in line at the community water pump.
1910
The indoor bathroom was a new luxury.
Today
Modern water facilities are utilized for a thousand purposes.

What's ahead for Water?



Population and industrial growth indicate a probable 73 per cent increase in water usage during the next twenty years.

Daily usage is expected to reach a staggering 284 billion gallons by 1975, twice the present-day consumption! This increase is created by a population forecast of 206 million in 1975, and an anticipated 50 per cent jump in industrial usage.

Extensive expansion of the water industry is expected to continue, with new construction projects and increased budgets enabling the industry to provide a supply of water adequate for future needs.

New techniques may further aid in supplying water requirements. Replenishing ground water resources by artificial means could store water underground with negligible loss through evaporation. Artificial induction of precipitation may help. Research, in processing sea water, could provide a new source of fresh water.

Yet, careful planning and allocation of water resources will be required to supply future development of the Nation. Additional water, from deep well sources, will help increase the supply. Efficient water systems, with modern facilities, and utilizing proper service equipment, will deliver water with minimum loss.

The tremendous progress of the water industry is ample proof of its ability to meet the challenge of the future.

MUELLER CO. **DECATUR, ILL.**

Factories at: Decatur, Chattanooga, Los Angeles;
In Canada: Mueller, Limited, Sarnia, Ontario

MUELLER CO. 100 YEAR QUALITY

Since 1857

need of employing check or other types of valves, or large and bulky water chambers and reservoirs.

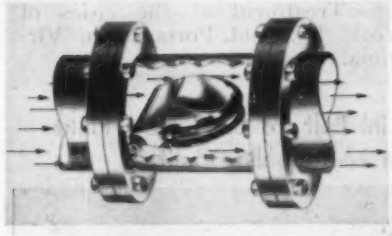
The new line uses a unique design of the volutes or guide vanes to enable the pumps to clear the suction line of air with only an initial priming charge of the liquid in the casing. The cast bronze guide vane has two volutes with cut-water. The cut-waters are equally spaced in respect to the circumference of the impeller. This design creates an unbalanced condition so that after a pump casing is filled with the liquid and the pump started, liquid will flow into the lower volute and pass the wide cut-water and liquid and air will flow out of the upper volute at the close cut-water.

The casing is so designed that when the pump is stopped, an adequate supply of the pump liquid is retained in the casing to reprime the pump, and in this way valves are not depended upon to accomplish this feature.

PVC Check Valve

110

Techno Corporation, Erie, Pa., has developed a new check valve made of polyvinyl chloride for handling corrosive gases, vapors and fluids.



Called Technocheck-PVC, the valve employs a unique and successful principle used by the company in the manufacture of their metal check valves.

According to information from the company their valve can be used in all PVC systems and installed in any position for handling salt solutions, fuels and oils, acids and alkalies, food products, liquors, alcohols and other materials for which PVC is recommended.

support Junior Achievement
PROVING GROUND FOR AMERICA'S FUTURE LEADERS

DURAJOINT®
Polyvinylchloride=PVC WATERSTOPS

ADVANTAGES

- Resistant to extreme waterhead pressures
- Tensile strength of not less than 1900 lbs. per square inch
- Superior holding strength . . . elongation ability of more than 350%
- Effective temperature range of —54°F. to +176°F.
- Chemically inert . . . resistant to acids, alkalis, weather, chlorinated water, oil, fungus, etc.
- Quickly, easily spliced "on-the-job" by merely applying heat and holding ends together . . . requires no welding or vulcanizing equipment
- Available in a type and size to meet the requirements of any particular climatic condition and head of water
- Supplied in lightweight, easy to handle 50 ft. coils . . . withstands abuse without damage

Have you compared "DURAJOINT" with your present waterstop materials? If so, you have already found out that *only* "DURAJOINT" offers *all* of the following important features:

BEST MATERIAL . . . "DURAJOINT" is extruded from a specially compounded polyvinylchloride (thermo-plastic) material that will outlast the useful life of the structure it's used in.

BEST DESIGN . . . "DURAJOINT'S" special longitudinal ridges insure the distribution of critical pressures and enhance the holding power. The hollow center bulb assists in providing for extreme elongation with full recovery.

STRONGER . . . "DURAJOINT'S" extreme elasticity and excellent tear resistance allow it to successfully handle movement of masses of concrete without being sheared.

ECONOMICAL . . . "DURAJOINT" may be installed at a substantial savings in material and labor costs over other waterstop materials . . . easily installed by unskilled labor.

NATIONALLY DISTRIBUTED!

"DURAJOINT" enjoys national distribution through the outlets of Tecon Products Inc. in the 11 western states and W. R. Meadows, Inc. in the other 37 states of the mid-western, southern and eastern portions of the United States. Write today for complete information and name of your local distributor.

A PRODUCT OF ELECTROVERT

Available in your area through . . .

TECON PRODUCTS INC.
304 S. ALASKAN WAY
SEATTLE 4, WASHINGTON

W. R. MEADOWS, INC.
30 KIMBALL STREET
ELGIN, ILLINOIS

GUNITE does it 2 times as fast at 1/2 the cost

"Gunite" is the modern process (sand and cement applied pneumatically) for repairing, constructing, lining:

- Reservoirs
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WRITE FOR MORE INFORMATION, INCLUDING 48 PAGE "GUNITE" BOOKLET.

PRESSURE Concrete Co.

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SPARLING MAIN-LINE WATER METERS have long been a standard of engineers and superintendents seeking the finest equipment at a moderate price.

Request information from any SPARLING OFFICE.

- MAIN-LINE METERS
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KANSAS CITY 6, MO.	6 E. Eleventh St.	248 London Rd.	ROMFORD, ENGLAND

W & SW Manufacturers' News

Dorr-Oliver Opens Baltimore Office

Dorr-Oliver Inc., Stamford-Conn., has announced the opening of a new office in Baltimore, Maryland at 2125 Maryland Avenue. The new office will serve the mid-Atlantic states of Virginia, West Virginia, Maryland and Delaware.

Sales Engineers Kelsey C. Lindstrom of Eastern Industrial Division and Benjamin F. Rockecharlie of Eastern Sanitary Division have been transferred to the new office from Division headquarters in Stamford, Conn.

Mr. Lindstrom joined the company in 1952 as a research and development engineer. After two years as a process engineer, he joined the Eastern Industrial sales division in February, 1955. He has handled D-O industrial sales in the mid-Atlantic area for the past two years.

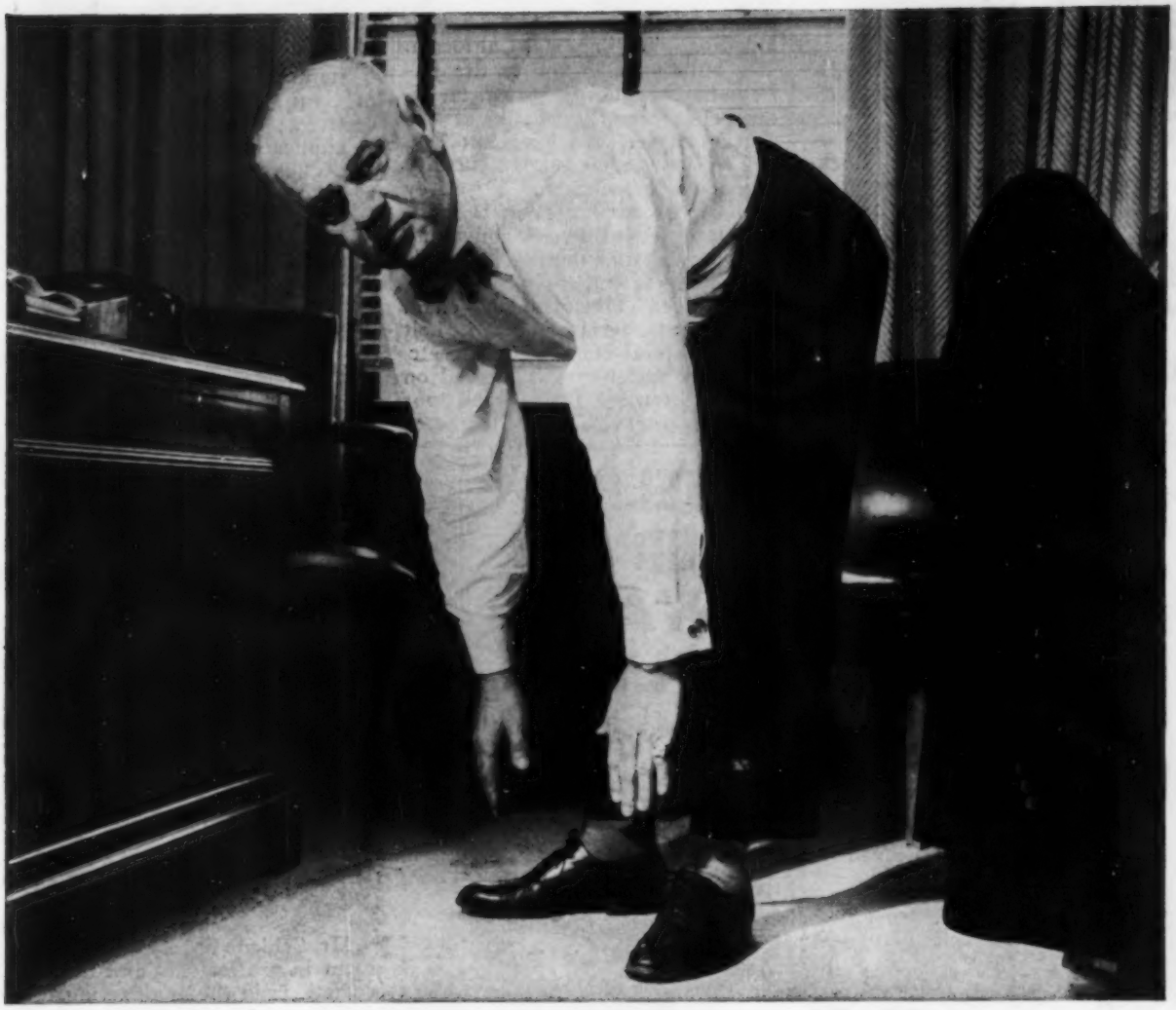
Mr. Rockecharlie joined the organization as a Sales Engineer in October, 1955. He had previously acquired a number of years of sanitary experience in the mid-Atlantic area as Superintendent of Sewage Treatment at the cities of York, Pa., and Portsmouth, Virginia.

Link-Belt To Build New Plant In Montebello, Calif.

Link-Belt Company, Chicago, Ill., has announced plans to build a new plant in Montebello, California, about 10 miles east of downtown Los Angeles, to replace and expand its facilities at 361 South Anderson Street, Los Angeles.

The Montebello plant will more than double Link-Belt's present manufacturing facilities in the Los Angeles area and will also house the company's factory branch store and district sales office. It will be a one-story construction of approximately 90,000 square feet of

(*Continued on page* 106*A*)



Time to consider your plant waste line, too!

How about the waste from your plant? Is it polluting streams... overloading municipal sewage treatment plants...causing annoyances to the public? Perhaps more important, is it wasting water and valuable materials?

There's a simple answer to the problem—CHAIN Belt's line of efficient industrial waste treatment equipment. Some units are "packaged"...complete in themselves and requiring only simple "piping-in" to plant waste lines. These units not only eliminate pollution... they can pay for themselves in the recovery of valuable materials from the waste...actually permit you to use water over and over again. It's an important factor in these days of water shortages.

If you're interested in turning waste into profit...saving water... send for your copy of Bulletin No. 315-92 for a quick, concise story of what CHAIN Belt Waste Treatment Equipment can do for you. Simply write CHAIN Belt Company, 4610 West Greenfield Avenue, Milwaukee 1, Wisconsin.

"Packaged" Verti-Flo in roofing products plant clarifies water for re-use and eliminates pollution.

Verti-Flo is a registered trade mark of CHAIN BELT CO.

CHAIN BELT COMPANY

Milwaukee 1, Wisconsin

floor space with air conditioned offices and engineering department. The structure will be about 250 feet by 300 feet over-all on a 25-acre tract located on Sycamore Street near Greenwood in Montebello and will include truck docks and a railroad siding connecting with the Santa Fe Railroad.

Jeffrey Opens West Coast Warehouse

The Jeffrey Manufacturing Company, Columbus, Ohio, has announced the opening of a San Francisco warehouse at 1862 Rollins Road, Burlingame, California. The building also houses the Jeffrey San Francisco sales Headquarters, formerly located at 870 Market Street, San Francisco.

The new 8500 sq. ft. facility augments the stock for 17 Jeffrey authorized distributors in 11 western states. A full line of conveying and power transmission parts is stocked, including chain, sprockets, pillow blocks, takeups, idlers, chain attachments, elevator buckets, belt pulleys, spiral conveyor parts etc. The new warehouse is located on the Southern Pacific Railroad spur and is convenient to numerous truck lines in the area.

Stanley M. Mercier is manager of San Francisco Sales Headquarters; William T. Davis serves as application engineer, and Henry G. Neubaumer is warehouse manager.

Harry Schlenz Assumes Presidency Of Manufacturers Assn.

Water & Sewage Works Manufacturers Association, New York, N. Y., has announced that on January 1, 1957, Harry E. Schlenz, president of the Pacific Flush Tank Company, Chicago, assumed the presidency of the Association. He succeeds J. A. Frank, vice president of the National Water Main Cleaning Co., New York, N. Y.

Mr. Schlenz has long been prominent in professional and trade associations in the engineering field. The Association's new president is among the youngest selected to head the manufacturers group which next year plans its 50th anniversary.

Serving with Mr. Schlenz are Richard Ford, vice president of the Ford Meter Box Co., Wabash, Ind., vice president, and Hubert O'Brien, president of the A. P. Smith Mfg. Co., East Orange, N. J., for his sixth term as treasurer. John G. Stewart and Dorothy Dimmers continue as manager and secretary, respectively, of the Association.

ONE WAY
TO HELP CONSERVE YOUR WATER SUPPLY
WATER is becoming more scarce, more expensive to obtain, treat, pump and deliver.
CONSERVATION starts with the efficient handling and delivery of water supplies — including meters, meter setting and testing equipment.
FORD
THE new Ford Catalog No. 56 is a water man's "bible". It not only pictures and lists the latest in meter servicing equipment, but it contains diagrams and much helpful data for the express purpose of conserving water through more efficient use of meters. It is available on request. Send for your copy today.
FORD
FOR BETTER WATER SERVICES
THE FORD METER BOX COMPANY, INC. Wabash, Indiana

That Did It!

Copper: No matter what you have to say, I'm pulling you in for being intoxicated.

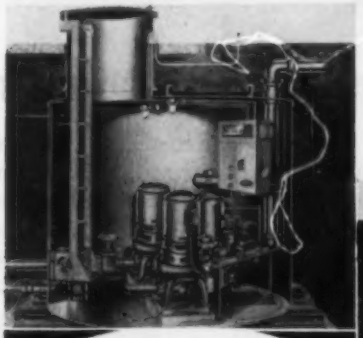
Lush: Don't shay that officer! Just because my eyes are a little red I'm not drunk. For all you know, maybe I'm a little white bunny.

Smith & Loveless

BUILDS FIVE (5) SEWAGE LIFT STATIONS FOR INDIANOLA, MISSISSIPPI

When bids were received for a sewer system at Indianola, Mississippi the cost of five (5) concrete lift stations exceeded the available funds.

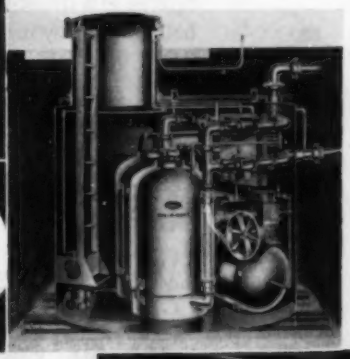
To reduce the cost of these stations the consulting engineers, Ewin Engineering Corporation of Mobile, Alabama, prepared new plans and specifications for factory-built lift stations as manufactured by Smith & Loveless, Inc.



ALL S&L PRODUCTS ARE PERMANENTLY PROTECTED WITH "VERSAPOX"

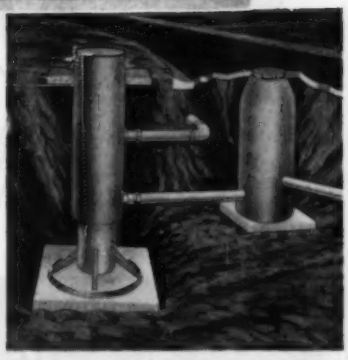
The Indianola lift stations recently installed are of both pump and ejector types as follows:

ONE — 8' diameter duplex pump station with 600 G.P.M. pumps.



TWO — 8' diameter "Way-O-Matic" duplex pneumatic ejector stations with 100 G.P.M. ejectors.

ONE — 9'-6" diameter "Way-O-Matic" duplex pneumatic ejector station with 200 G.P.M. ejectors.



ONE — 4' diameter "Mon-O-Ject" single pneumatic ejector station with 40 G.P.M. ejector and stand-by motor, compressor and controls.

For job recommendations, complete specifications and drawings—all part of the latest edition of the 100 page Smith & Loveless lift station Data Manual . . .

WRITE DEPARTMENT 20

Hundreds of cities are reducing costs with Smith & Loveless "proven quality" lift stations.

S&L Smith & Loveless, Inc.

P.O. BOX 8172 KANSAS CITY, MISSOURI

PLANT: MERRIAM, KANSAS

REPRESENTATIVES IN PRINCIPAL CITIES

Brindel & Hennesssy Appointed B-I-F Pacific Office Managers

B-I-F Industries, Inc., Providence, R. I., has announced the appointment of Frank D. Brindel as manager of the Berkely office of B-I-F Pacific, and Paul V. Hennessy as manager of the Los Angeles office.

Mr. Brindel is a graduate petroleum engineer from the University of Tulsa. His professional affiliation include the I.S.A. and the American Petroleum Institute.

Mr. Hennessy received his BS from the University of California. A registered professional engineer in California, his professional affiliations include the A.S.C.E., California Sewage Works Assn., the F.S.I.W.A., the AWWA, the Arizona Sewage and Industrial Waste Assn., and the Engineers Club of Southern California.

James Cook Joins Hays Manufacturing

Hays Manufacturing Company, Erie, Pa., has announced the appointment of James B. Cook, Jr. as sales manager of the company's General Products Division. Mr. Cook will have charge of Hays General Products Division sales to water and gas utilities, manufacturers and wholesale distributors throughout the United States.

Mr. Cook is a graduate of the University of Rhode Island, from which he received a B.S. degree in Chemical Engineering. Following graduation he spent ten years in sales work with Proportioneers, Inc. He comes to Hays from the C. I. Thornburg Co., Inc. of Huntington, W. Va., distributors of waterworks, sewage and industrial supplies, of which company he was Vice President and sales manager.

Hagan Corporation Changes Name

Hagan Corporation, Pittsburgh, Pa., has announced that the company name has been changed to Hagan Chemicals & Controls, Inc.

It was also announced that its subsidiaries, Calgon, Inc., Hall Laboratories, Inc., and The Buromin Company have been merged into the parent company. Calgon and Hall will continue as divisions.

Hagan controls and instrumentation systems are widely used throughout industrial operations, and the company recently expanded its line of industrial products to include a mechanical type dust collector.

Hall Laboratories provides consultation and engineering service on industrial water problems—from analysis of sources through to waste water disposal.

Armco Purchases Pekrul Gates

Armco Drainage & Metal Products, Inc., Middletown, Ohio, has announced the purchase of the well known line of Pekrul gates from Morse Brothers Machinery Company, Denver, Colorado.

Now, according to Armco officials, the complete line of gates enables the company to better serve all users of gates, including water and sewage treatment works. This will make it possible for contractors to obtain from one source any type of standard gate with many

The name MATHEWS means the

THE MATHEWS MODERNIZED HYDRANT

The hydrant with the *replaceable* barrel. A Mathews broken in a traffic accident can be repaired in less than half an hour by inserting a new barrel without *excavating*. In addition this high-quality hydrant is very simply constructed. It is the *dry-head* type which functions under all conditions, because water, ice and sediment cannot reach key parts to clog operation.

MATHEWS HYDRANTS | made by

related Armco drainage products, such as Smooth-Flo sewer pipe and welded steel pipe.

A complete line of Armco gates will now be manufactured in a new million dollar plant in Denver, Colorado. Built on a 15-acre site, it will have nearly 73,000 square feet of space and will be the company's largest plant in the Rocky Mountain division. Its completely modern equipment and trained personnel will make possible prompt service to contractors and other users everywhere. Other Armco drainage and construction products will also be fabricated here.

Chamberlain Appointed District Engineer For B-I-F

B-I-F Industries, Inc., Providence, R. I., has announced the appointment of Leon H. Chamberlain as District Engineer for Water and Sewage Sales for the entire West Coast region.

Mr. Chamberlain attended the University of California, and served with several major industries in the Water and Sewage field before becoming President of B-I-F Pacific, Inc., the West Coast Division of B-I-F Industries. His professional affiliations include: A.S.M.E., AWWA, F.S.W.A., I.S.A., and the F.S.I.W.A.

Harry Smith Joins Staff Of Cast Iron Pipe Research Assn.

The Cast Iron Pipe Research Assn., Chicago, Ill., has announced that W. Harry Smith, of Champaign, Illinois, has joined the Association staff.

Mr. Smith has worked with the Illinois Department of Public Health and the Illinois Sanitary Water Board for the past eight years. He was appointed Regional Engineer in 1951 and in this capacity has assumed the responsibility for all the sanitary engineering field work in his area.

He completed his academic preparation in 1948 and received his degree in Sanitary Engineering from the University of Illinois. He received part of his undergraduate training in Princeton University.

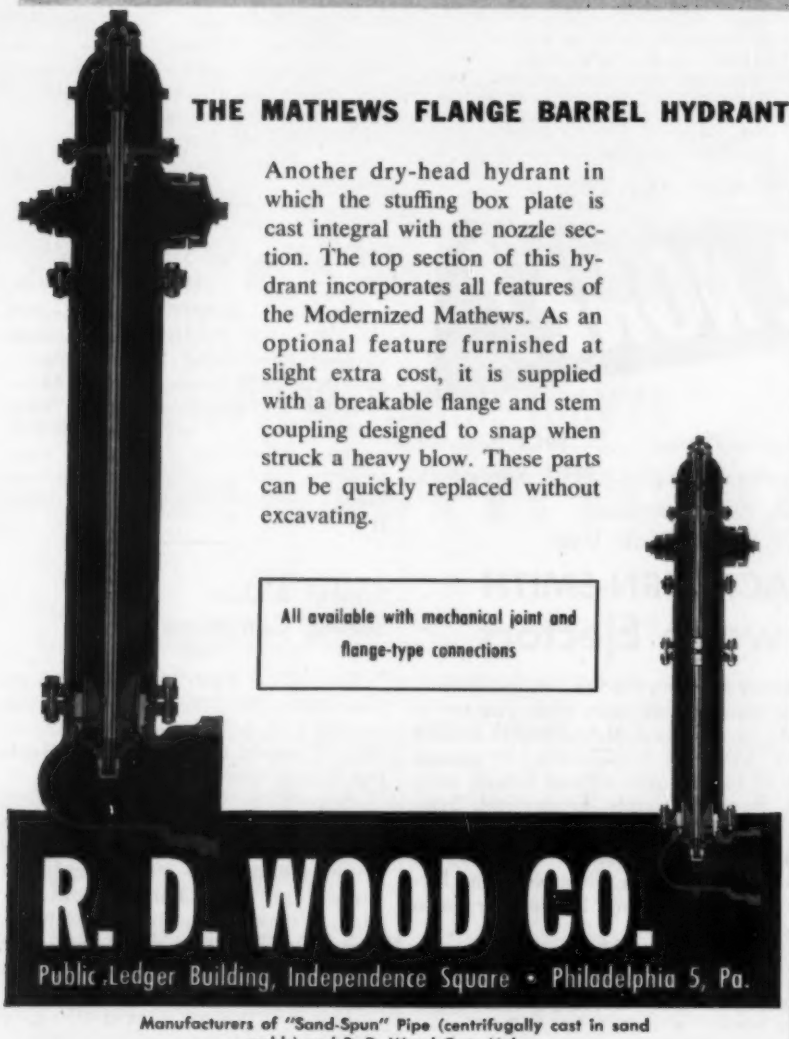
DeZurik Shower Company Changes Name

DeZurik Shower Company, Sartell, Minnesota, has announced a change in its corporate name to DeZurik Corporation.

The name change reflects the typical growth-pattern of many American industries. At its inception in 1932, the company's principal product was a paper-mill shower, hence the name DeZurik Shower Co. Under the current circumstances, the term "shower" in the company's name is no longer indicative of the firm's activities, and the name is therefore being changed to the broader designation of DeZurik Corporation.

Primary among today's DeZurik products is an eccentric-type, nonlubricated plug valve, ranging in size from ½ thru 20 inches, and produced in an extensive line of types and body metals.

on hydrants
finest in fire protection



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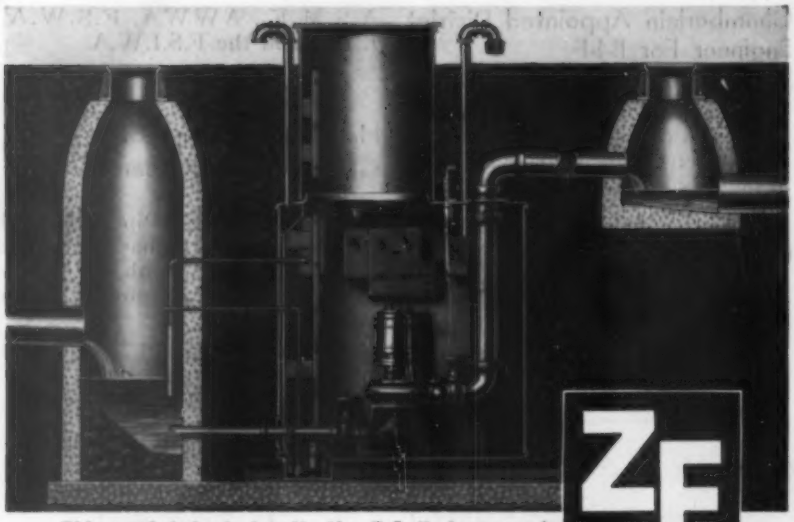

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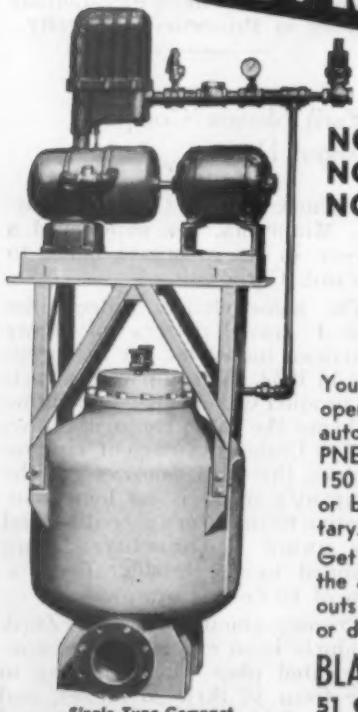

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W&SW

New Literature

Rate Recorder For Water Meters

111

F. S. Brainard & Company, Hartford, Conn., has just published a 4-page bulletin on the new **Dual Pen Model Meter Master,** the standard rate recorder for water meters.

The bulletin describes the Meter-Master as the "G-Man" of water works everywhere and lists the following advantages: (1) Solves the perplexing problem of high bill complaints, (2) Detects the presence of leaks, (3) Helps determine correct meter sizes, and (4) Converts any standard meter into a demand meter.

According to the bulletin, the new Meter-Master can be attached to any meter, single or compound. On compound installations it simultaneously records both sides of the meter on a single chart. The back cover reproduces four charts showing how the Meter-Master was used to detect size of meter required.

F & P General Stock Catalog

112

Fischer & Porter Co., Hatboro, Pa., has just published a 32-page catalog describing the company's products which are available for **"Immediate Shipment".** The new catalog, which includes prices, covers indicating, recording, controlling, and transmitting instruments for flow, pressure, and density.

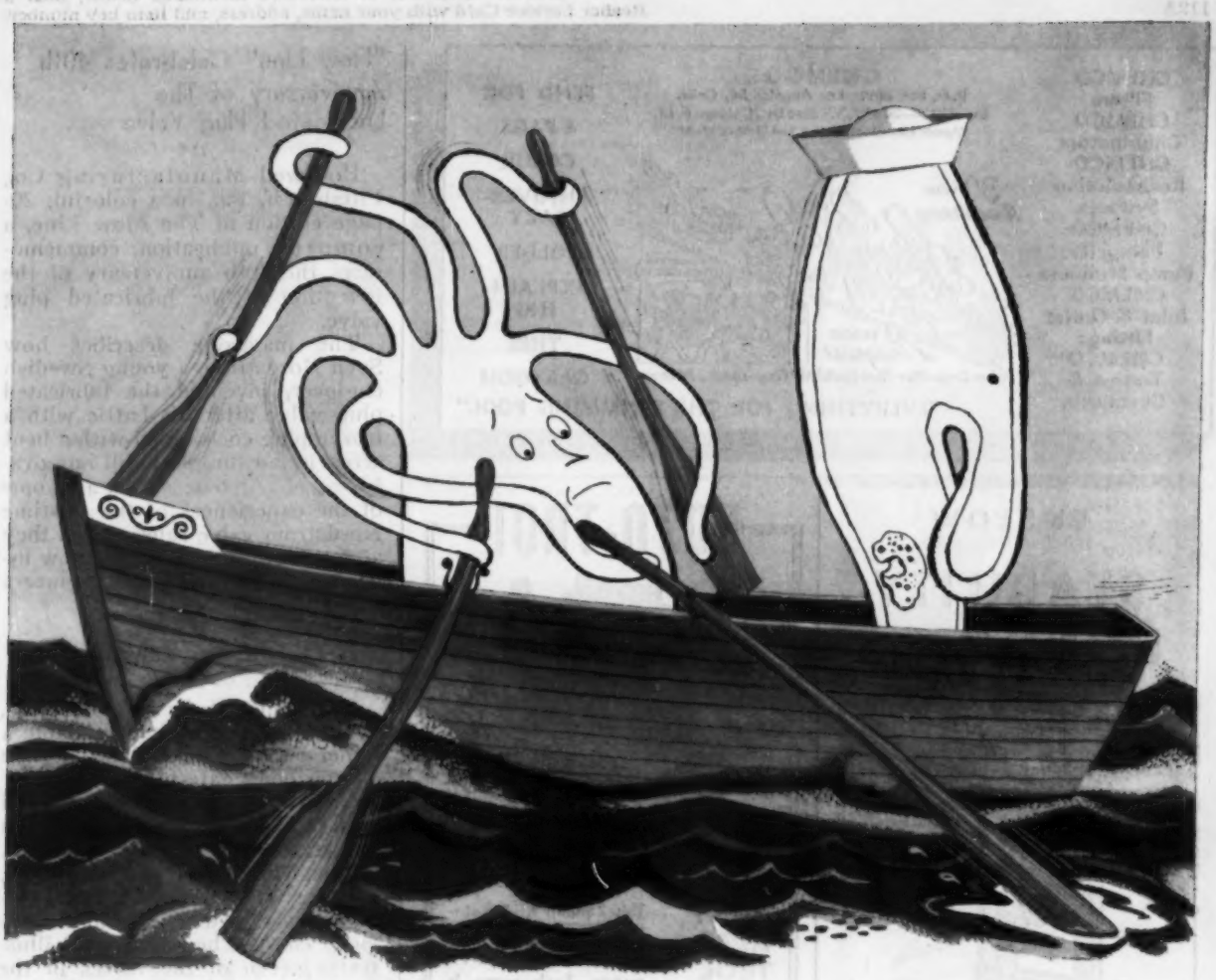
Gasket & Joint Sealing Compound

113

Radiator Specialty Company, Charlotte, North Carolina, has available 3 loose-leaf sheets on their **Titeseal Gasket & Joint Sealing Compound.**

According to the information sheets, Titeseal is unaffected by water, oil, gasoline, ammonia, glycerine, steam, gas vapor, exhaust fumes and most hard-to-hold liquids. Withstands extreme temperatures; will not shrink, crack or crumble. It also prevents corrosion and "freezing" of metal parts.

The information sheets also give prices and shipping information.



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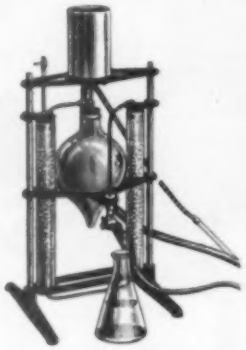

For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

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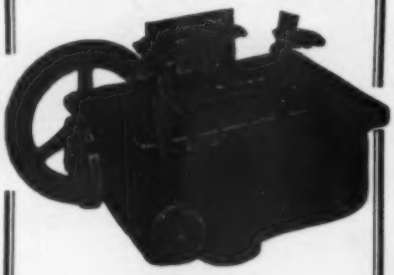

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"Flow Line" Celebrates 40th Anniversary of The Lubricated Plug Valve

114

Rockwell Manufacturing Co., Pittsburgh, Pa., in a colorful, 20-page edition of **The Flow Line**, a company publication, commemorates the 40th anniversary of the invention of the lubricated plug valve.

The magazine describes how Sven Nordstrom, a young Swedish engineer, invented the lubricated plug valve after his battle with a frozen plug cock ended with a bent wrench and the plug still immovably stuck. Also described are some of the experiences of the old-time Nordstrom valve salesmen as they attempted to introduce the new invention to the industrial engineers of the time.

Iron Body Gate Valves

115

The Ohio Injector Company, Wadsworth, Ohio, has available a folder on the **OIC Industrial Line** of iron body gate valves.

Cut-away drawings with keyed text explain in detail the operation and features of the OIC valves. A full page is devoted to a trim chart, working pressure chart, test pressure chart, and a general dimensions chart. The back cover illustrates seven of the valves in the line along with valve indicators, operators, clean-out and quick opening features available.

Separan 2610 In Water, Waste And Sewage Treatment

116

Dow Chemical Co., Midland, Mich., has just published two booklets reporting the latest results in water, waste and sewage treatment entailing the use of Separan 2610 as a flocculating agent.

"Separan 2610 in Water Treatment" offers data showing how Separan 2610 has improved the clarity of treated water, increased the settling rate of precipitated and suspended solids, improved the throughput of existing equipment, and decreased treatment costs. Methods of solution preparation and use are also given.

"Separan 2610 in Waste and Sewage Treatment" reports that by using Separan, metal finishing wastes handled on a batch basis in a 45,000 gallon tank were settled in from ⅕ to ⅓ the time required previously.

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Corrosion Resistant Equipment
117

Haveg Industries, Inc., Wilmington, Delaware, has just released a 32-page catalog covering their line of **Corrosion-Resistant Plastic Equipment.**

The catalog, which marks the company's 25th anniversary, gives complete coverage to Haveg's wide range of synthetic resin formulations. In addition, it describes Haveg's newer products and materials.

The bulk of the catalog details Haveg-made equipment: pipes and fittings, valves; fume ducts and fume systems; tanks, towers and accessory supplies; heat exchangers; pressure and vacuum equipment; and agitators. The booklet also includes data on chemical-resistant cements, the field construction of plastic equipment, and Haveg's design service.

Automatic Chlorine Proportioning
118

Fischer & Porter Co., Hatboro, Pa., has just published a new catalog describing the company's Rotating Vacuum Transmitter for automatic chlorine proportioning.

According to the catalog, the rotating vacuum transmitter is used with a rotating type flowmeter and a chlorinator. The transmitted signal regulates chlorine feed in direct proportion to the main line flow. Operation and installation diagrams are also included.

Inorganic Zinc Coating
119

Amercoat Corporation, South Gate, Calif., has just released a new 4-page bulletin on **Dimetcote,** the inorganic zinc coating for dam gates, structures, walkways, piping, racks, gratings and tanks.

According to the bulletin, the coating is unusually resistant to fresh and salt water, weathering and abrasion. One spray coat affords the same physical and cathodic protection as galvanizing, and lasts up to 15 years. The illustrated bulletin describes the general physical and chemical properties of Dimetcote.

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Water Analysis

120

Solvay Process Division, Allied Chemical & Dye Corporation, New York, N. Y., has announced a revised, enlarged edition of their technical and engineering service bulletin #11—**"Water Analysis".**

Solvay advises that this 100-page bulletin, which is one of the most widely requested in their entire line of technical bulletins, contains separate sections on the analysis of various types of water including —municipal, railroad, swimming pool, polluted and stationary boiler water. Also included in the bulletin are numerous tables of analytical data, conversion factors and turbidimetric and color standards, and a special section on the preparation of reagents, indicators and standard solutions used in analyses.

Liquid Control Equipment

121

Simplex Valve and Meter Co., Lancaster, Pa., has published a general catalog on **Simplex Equipment For The Measurement And Control of Liquids And Gases.**

This amply illustrated 36-page catalog is broken down into 7 different categories: Primary elements; Meters; Orthoflow; Laminair; Gauges; Controllers; Valves; and Pilot equipment. Engineering drawings and dimensional tables are also included.

Sewer Structures

122

Armco Drainage & Metal Products, Inc., Middletown, Ohio, has issued a revised edition of its comprehensive 48-page manual on **Sewer Structures.**

The book covers such subjects as structural durability; material durability; selection of structures; factors influencing capacity; joints and fittings; and linings for failing sewers. Installation design and reference data are included, as well as seven pages of graphs showing discharge of pipe based on Manning's formulas.

Sidecrane-Backfiller-Tamper

123

The Cleveland Trencher Co., Cleveland, Ohio, has just released a 12-page, 2-color bulletin on the **Cleveland 80W,** a versatile 3-way machine for the utilities field.

The bulletin shows in detail how the special design and construction features of the 80W are employed advantageously under a wide variety of operating conditions in sidecrane, backfilling and tamping work.

28 on-the-job action photographs demonstrate the varied operations of the 80W as it performs the related functions of pipelaying, backfilling and tamping. The text includes case history reports on the use of these machines. Complete dimensions and specifications are given in detail.

Safeguard Rotameters

124

Schutte and Koerting Company, Cornwells Heights, Pa., has just published a new bulletin describing the company's line of Series 18200 **"Safeguard" Rotameters.**

This 12-page, 2-color bulletin describes Rotameter principles and illustrates components common to all such flow measuring instruments. How SK "Safeguard" Rotameters meet pressure, corrosion, and modern day safety and other conditions are described in detail.

The bulletin gives detailed data on application, construction, operation and installation of the meters and pictures and describes the various types which make up the complete line.

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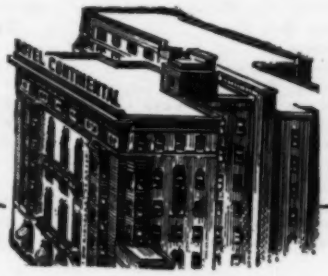

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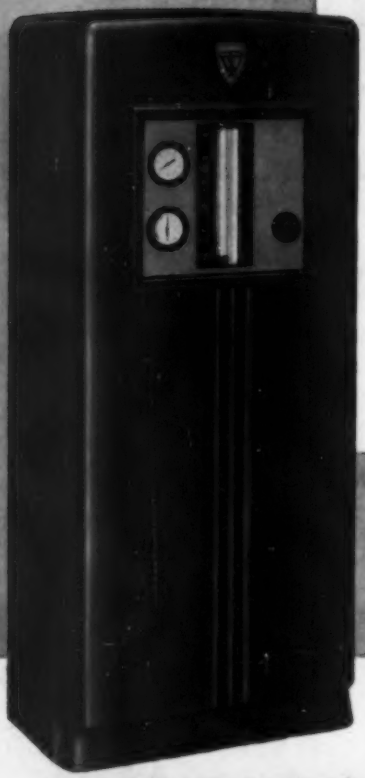

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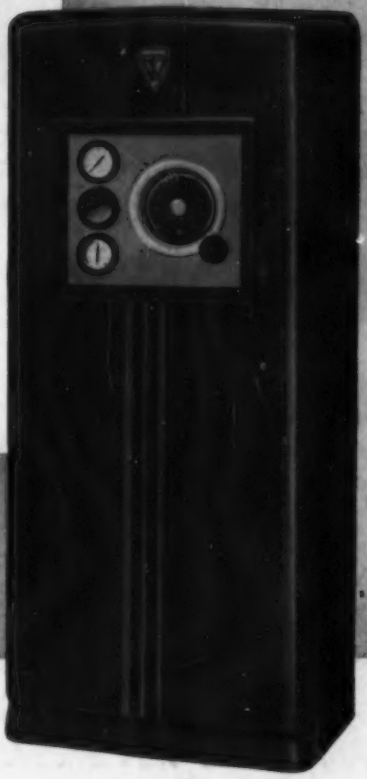

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